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(54) **CUTTING BLADE ASSEMBLY AND MEDICAL APPARATUS COMPRISING A CUTTING BLADE ASSEMBLY THEREFOR**

SCHNEIDKLINGENANORDNUNG UND MEDIZINISCHE VORRICHTUNG MIT EINER
SCHNEIDKLINGE DAFÜR

ENSEMBLE LAME D'INCISION ET APPAREIL MEDICAL COMPRENANT UN ENSEMBLE LAME
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Description

Field of the Invention

[0001] The present invention relates to an improvement in a medical apparatus used during the performance of eye surgery. In particular, the present invention is directed towards an improved cutting blade assembly to be used in conjunction with an automatic surgical device for cutting the cornea of a patient's eye.

Description of the Related Art

[0002] Until about twenty years ago, refractive errors of light passing through the eye could only be treated with eyeglasses or contact lens, both of which have well known disadvantages for the user. Consequently, in the last several years, research has been directed to surgical operations to change the refractive condition of the eye, i.e., either to flatten or increase the curvature of a patient's eye depending upon his or her condition. The desired result of such surgical operations is that light rays passing through the cornea will be refracted to converge properly and directly onto the retina so as to allow a patient to clearly see close or distant images.

[0003] Automated Lamellar Keratectomy (ALK) is one surgical technique developed wherein the eye is first numbed by a drop of anesthetic, and then a suction ring is placed on the eye to carefully position the cornea (termed "centration" in the art) for being cut by a very fine microsurgical instrument known as a microkeratome. The microkeratome is generally a blade carrying device that must be manually pushed or mechanically driven in a cutting path across the suction ring simultaneous with the motorized movement of the cutting element, which movement is transverse to the direction of the cutting path. For treating myopia pursuant to ALK procedures, the microkeratome is typically used to first cut into the cornea so as to raise and separate a thin layer of the anterior cornea of between 100 - 200 microns in depth and about 7 millimeters in diameter. Next, the microkeratome is then used to make a second pass over the cornea to resect or remove a smaller part of the cornea, generally about 4 to 6 millimeters in diameter, which is then discarded. The anterior corneal cap which was cut away with the first pass of the microkeratome is then put back into its original position, without suturing, for healing to occur. The desired result of this procedure is that the cornea will have a new curvature because of the resected tissue, which provides a new refracting surface to correct the patient's original myopic condition. To correct hyperopia under ALK however, the microkeratome is typically used to make a single deep pass over the cornea. The cut layers are put back into their original position, without any removal of any other tissue. Because of the depth of the cut, the intraocular pressure within the eye causes a steepening of the cornea to again, provide a new refracting surface which

hopefully will correct the patient's original hyperopic condition.

[0004] Another more recent advance in surgical procedures to correct refractive errors of the eye involves the introduction of laser procedures. One such procedure, known as Laser Intrastromal Keratomileusis, (LASIK), is currently considered optimal because it allows sculpting of the cornea by a laser, without damaging adjacent tissues. Moreover, with the aid of computers, the laser can be programmed by a surgeon to precisely control the amount of tissue removed, and significantly, to permit more options for the reshaping of the cornea. Under LASIK procedures, the eye is still typically positioned within a suction ring and a microkeratome is typically used to cut into the cornea so as to raise a thin layer of the cornea.

[0005] In recent years, it has been learned that regardless of whether ALK or LASIK surgery is performed, the microkeratome which cuts the cornea should not create a corneal cap nor separate the cut corneal tissues completely from the rest of the cornea. The reasons are primarily two-fold: first, the possibility exists that when the corneal cap is put back in place on the cornea, it will not be aligned properly with the remaining corneal tissues, which has several drawbacks for the patient, and second, the possibility exists that the corneal cap will become lost during the surgery, and if that occurs, the consequences for the patient are catastrophic. In great part to overcome these problems, among others, the inventor of the invention described in the present application created and developed an improved surgical device for cutting the cornea which automatically and reliably leaves a portion of the raised and separated corneal tissues connected or "hinged" to the eye, thereby forming a raised layer of corneal tissue hinged to the eye, known as a corneal flap F, illustrated in Figure 1.

[0006] Significantly, it has been determined that the corneal flap should have a depth of no less than 130 microns and no more than 160 microns to yield optimal results. It should be borne in mind that achieving this result during surgery requires an extremely precise instrument as one micron is a unit of length equal to one thousandth of a millimeter. Further, it is desirable, if not imperative, for the microkeratome to cut across the cornea in a manner that will very finely and smoothly cut the corneal tissues. In this regard, there is a need in the art for improvement in that when the smoothness of a cut made to the cornea by known microkeratome devices is closely examined under a microscope, the cut, corneal tissue edges are seen to be a bit irregular, if not slightly jagged. It would be ideal if a microkeratome device were able to cut across the cornea, not only so as to cut and raise the microscopically thin layer of corneal tissue currently considered optimal, but to do so in a manner which results in a noticeably improved cut to the cornea, namely, by yielding very fine, smooth and almost undetectable cut corneal tissue edges.

[0007] In addition, there is room for known microkeratome devices to be improved with regard to the assembly required prior to performing surgery on a patient's eye, as well as with regard to the disassembly, sterilization and cleaning of the device, or parts thereof, following surgery. Specifically, microkeratome devices, and particularly, the cutting blade housed therein, which penetrates into and cuts the cornea must be in a proper sanitary and sterilized state until generally about the moment when surgery on the eye is to begin. Known microkeratome devices, however, have required that the housing for the cutting blade be manipulated so as to create access to an interior thereof and permit the placement of the cutting blade therein, which itself must typically be handled as well, after which, the housing must again be manipulated so as to close off the access means, all of which has hopefully resulted in the cutting blade being properly in place. This excessive manipulation required of known microkeratome devices is not conducive, however, to maintaining the proper sanitary and sterilized state required for surgery. Moreover, in manipulating the access means of certain known microkeratome devices, some surgeons have unintentionally caused the cutting blade to become dislodged, or worse, have even bent the cutting blade, thereby requiring the assembly process to start over again. Further, the mechanisms within known microkeratome devices for holding the cutting blade have been designed for repeated use. This factor tends to only exacerbate the problems encountered in the art in that these known blade holding mechanisms should also be removed from the microkeratome device following a surgery in order to be properly cleaned and/or sterilized for subsequent use. The assembly and disassembly of these mechanisms are not only tedious and time consuming, but are fraught with the difficulties of maintaining sterilization and ensuring proper re-assembly.

[0008] Consequently, there is a need in the art for an improved microkeratome device for cutting the cornea of a patient's eye which can easily receive and which facilitates the proper positioning of a cutting blade therein, without excessive manipulation. There is also a need for an improved cutting blade assembly that facilitates easy insertion within a microkeratome device, with little danger of becoming bent, while simultaneously offering the user the knowledge that it is securely and properly in place. Any such improved cutting blade assembly should similarly be quickly and easily removed from the microkeratome device, and will preferably be disposable. It would be ideal if any such improved cutting blade assembly could be readily packaged in containers that permit sterilization prior to shipping, and which remain sterilized during shipping, and further, which could be easily removed from the sterile packaging for insertion into the microkeratome while maintaining sterility. In this regard, any such improved cutting blade assembly would ideally include an instrument which facilitates the removal of the assembly from a sterile container and the

insertion thereof into the microkeratome, while maintaining sterility.

[0009] Known microkeratome devices are thought to have other, fairly significant deficiencies as well. For example, when a surgery on a patient's eye is underway, at times the suction or vacuum provided to temporarily attach the positioning ring to the cornea is either broken or interrupted. Given the precision cutting which is needed for such surgeries, however, it is highly undesirable, for the eye to continue to be cut during such situations. To date, known microkeratome devices continue cutting in such situations. Thus, it would be highly beneficial to provide an improved microkeratome device with a control assembly that could detect problems encountered during the surgical cutting of the cornea and that will shut off power supplied to the device when problems are detected so as to stop the cutting of the cornea by the microkeratome. Moreover, if surgery on a patient's eye is proceeding well, but there is sudden power loss, any such control assembly should enable the microkeratome device to continue functioning during the rather short duration of the operation, without interruption, both in terms of continuing to ensure a power supply to the device and a supply of vacuum to the positioning ring.

[0010] EP 0442156A1 relates to a microkeratome that cuts the cornea of the eye and uses a rectangular cutting blade.

[0011] U.S. Patent No. 4,917,086 relates to a dermatome used to graft skin. The dermatome of this reference uses a completely rectangular blade and cuts in a linear path. Attached to the blade is a second part preferably being formed of lightweight plastic that includes chamfered corners. The primary goal of the chamfered corners on this second part is to avoid cutting a person handling the blade.

[0012] U.S. Patent No. 2,457,772 also relates to a dermatome used to graft skin by cutting in a linear path. The dermatome of this reference uses a blade with tapered sides, but with no blade holder. Instead, the blade is screwed onto a carriage which is mounted in the frame cross bars. The oscillation of the blade occurs within the frame of the dermatome.

SUMMARY OF THE INVENTION

[0013] The present invention is designed to satisfy the needs which remain in the art of microkeratome devices used to cut the cornea of a patient's eye. In this regard, the present invention is directed towards an improved microkeratome which is able to cut and raise a microscopically thin layer of corneal tissue in a manner that results in very fine, smooth and almost undetectable cut corneal tissue edges. In addition, the present invention is directed towards an improved microkeratome cutting blade assembly that permits quick and easy installation and removal from the microkeratome housing, without excessive manipulation. The present invention may be

used in combination with a control assembly for a microkeratome device that is capable of detecting problems encountered during the surgical cutting of the cornea and either shutting off power supplied to the device, if appropriate, or ensuring that power and/or a vacuum continue to be supplied to the device, if appropriate.

[0014] The cutting blade assembly as defined in claim 1 is seen to comprise an improved cutting blade and blade holder. The cutting blade comprises a front portion that includes a sharp, forward cutting edge, a rear, trailing portion having a rear edge, and a pair of side edges that extend and taper at least partially between the front and rear trailing portions. The cutting blade preferably further includes at least one aperture formed therein, and more preferably, a pair of apertures disposed in the rear, trailing portion in substantially aligned relation with one another. Preferably, the cutting blade is substantially flat and made of stainless steel, with the front portion of the cutting blade having an overall dimension which is larger than the rear trailing portion. The blade holder of the improved cutting blade assembly is formed so that an underside thereof is secured to the cutting blade at the at least one aperture on the cutting blade, and so that a top side of the blade holder includes means for being operably driven by the drive means of the microkeratome device, which may comprise a recess formed within the blade holder. In the preferred embodiment, the blade holder will be molded of a plastic material and will be press fit during manufacture into the at least one aperture on the cutting blade so as to provide an integrally formed cutting blade assembly. In a most preferred embodiment, the cutting blade assembly of the present invention will additionally comprise a tool which facilitates the removal of the cutting blade and blade holder from a sterile packing container and the insertion thereof in a microkeratome device, while maintaining sterility.

[0015] A primary object of the present invention is to provide an improved microkeratome and cutting blade assembly that markedly improves the cutting of the cornea, namely, one that is able to cut and raise a microscopically thin layer of corneal tissue in a manner that results in very fine, smooth and almost undetectable cut corneal tissue edges, which can then be easily and more precisely aligned back into an original position on the cornea following the reshaping of the cornea.

[0016] Another primary object of the present invention is to provide a microkeratome device with improved access means for ensuring that either or both a cutting blade and blade holder can be easily and quickly installed for surgical use on a patient, while at the same time, facilitating cleaning of the microkeratome and one or more of its internal mechanisms.

[0017] It is a further important object of the present invention to provide a cutting blade assembly which is easily and quickly installed within a microkeratome device in preparation for surgical use on a patient, without excessive handling so as to maintain the sanitary con-

dition of the assembly and device, and further which quickly offers confirmation that the assembly is securely and properly in place within the microkeratome.

[0018] It is also an object of the present invention is to provide an improved cutting blade and blade holder which is integrally formed and consequently, which is easy to remove from a microkeratome device, and ideally, which is disposable.

[0019] Yet another object of the present invention is to provide a cutting blade assembly which is readily packaged in containers that permit sterilization prior to and which remain sterilized during shipping, and further, which is easily removed from the sterile packaging for insertion into the microkeratome while simultaneously maintaining sterility.

[0020] A further object of the present invention is to provide a cutting blade assembly which can be used with either presently known microkeratome devices or with those that may be developed in the future.

[0021] It is a further object of the present invention is to provide an improved automated microkeratome device which is not only readily usable on either a patient's left or right eye, but which readily informs a surgeon as to which eye the device is assembled for use on.

[0022] An improved microkeratome device may comprise a control assembly which will not allow the cutting of the cornea to continue during a surgery when the vacuum seal between the positioning ring and the eye becomes compromised and/or is broken.

[0023] The control assembly for a microkeratome device is capable of detecting problems encountered during the surgical cutting of the cornea and has back up capabilities to ensure that power and/or a vacuum continue to be supplied to the device.

[0024] The control assembly for a microkeratome device is internally electrically isolated between the high voltage and low voltage sides, while still permitting necessary checks and interaction between the components on both sides.

[0025] The control assembly for a microkeratome device will not permit a motor to burn out if substantial resistance is encountered by the device as it cuts the cornea during an operation.

[0026] These and other objects, features and advantages of the present invention will be more readily understood upon consideration of the accompanying drawings as well as the detailed description of a preferred embodiment for the invention, which is set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] For a fuller understanding of the nature of the present invention, reference should be made to the following detailed description taken in connection with the accompanying drawings in which:

Figure 1 is schematic illustration of a cornea of an

eye wherein a corneal flap has been created.

Figure 2 is an exploded perspective view of a preferred microkeratome retaining and positioning means, of a preferred microkeratome cutting head assembly, as well as a preferred microkeratome coupling member.

Figure 3 is a cross sectional view of the retaining and positioning means shown in Figure 2.

Figure 4 is a partial side view of the preferred microkeratome illustrated in Figure 2 in assembled form and in position on a patient's cornea.

Figure 5 is a partial cross sectional view of the preferred microkeratome illustrated in Figure 4.

Figure 5-A is a partial cross sectional view of the preferred microkeratome in a partially disassembled state so as to illustrate the improved access means, without a cutting blade assembly inserted therein.

Figure 6-A is a side view of the cutting blade assembly according to the present invention in a preferred embodiment.

Figure 6-B is a top plan view of the cutting blade assembly illustrated in Figure 6-A.

Figure 6-C is a bottom view of the cutting blade assembly illustrated in Figure 6-A.

Figure 7 is a top plan view of the cutting blade assembly of the present invention in an alternative embodiment.

Figure 8 is a side view of a tool which facilitates the removal of the cutting blade assembly shown in Figures 6 and 7 from a sterile packing container and the insertion thereof in a microkeratome device, while maintaining sterility.

Figure 9 is an isolated perspective view of the drive means for the preferred microkeratome device and illustrating the operation and interconnection of the worm, worm gear, and oscillating shaft with the means of the blade holder, in the form of a recess, for being operably driven by the drive means of the microkeratome device.

Figure 10-A is a front schematic illustration of the preferred microkeratome in use on both a patient's left and right eyes and illustrating the cutting head assembly in the initial position.

Figure 10-B is a front schematic illustration of the preferred microkeratome illustrated in Figure 10-A but depicting the cutting head assembly in the movement stopped position wherein a corneal flap has been formed with the resulting hinged portion being oriented so as to cooperate with the blinking of the eye following surgery.

Figure 11 is a perspective, partial cut away view of a preferred control assembly configuration which is to be used with a microkeratome device such as illustrated in Figure 2.

Figure 12 is an isolated diagram of the configuration of a preferred optic coupler for the control assembly.

[0028] Like reference numerals refer to like parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0029] As illustrated throughout the Figures, the present invention is directed towards an improved automatic microkeratome device for smoothly cutting the cornea of an eye, generally indicated by reference numeral 10, and towards a cutting blade assembly therefor, generally indicated by reference numeral 105, and towards a control assembly therefor, generally indicated by reference numeral 200.

[0030] The preferred and improved automatic microkeratome device of the present invention, which is structured to cut substantially but not completely across the cornea of a patient's eye so as to raise a thin layer thereof and create a hinged flap of corneal tissue, will be discussed first. As illustrated in Figures 2 and 3, the preferred microkeratome device 10 includes means 30 for retaining and positioning the eye on which surgery is to be performed. The retaining and positioning means 30, which may be made of high grade stainless steel, preferably comprise a positioning ring 32 having an aperture 33 formed therein. The aperture 33 is sized to permit the cornea C, of the eye to pass therethrough and be exposed, as depicted in Figure 3. As illustrated, the positioning ring 32 is preferably defined by a generally teardrop shape.

[0031] Positioning ring 32 further includes means for being temporarily attached to a portion of the eye surrounding the cornea on which surgery is to be performed. Ideally, the temporary attachment means include suctioning means. For example, positioning ring 32 preferably includes a connection member 37, which as illustrated in Figure 2 and 3, is in fluid communication with an undersurface of positioning ring 32. Connection member 37 is adapted to be interconnected with a vacuum hose 202, which as shown in Figure 11, may be connected to a vacuum pump 210, such that when suction occurs, the undersurface of positioning ring 32 forms a seal about and is retained about the corneal portion of the eye which is about to undergo surgery. Further, the structure of positioning ring 32, accompanied by the suctioning, acts to properly position the cornea C, for surgery and to maintain the position during surgery as well. Typically, a vacuum of about 25 inches of Hg at sea level will be used.

[0032] The retaining and positioning means 30 further include guide means 40 formed thereon, best illustrated in Figure 3. Guide means 40 may be formed directly on the positioning ring 32, so as to be integral therewith, or may be operably connected thereto as a separate element. In any event however, the guide means 40 will be disposed on positioning ring 32 so as to guide and facilitate movement of the cutting head assembly 50, discussed below, during the surgical cutting of the cornea.

Referring to Figure 3, in the preferred embodiment, guide means 40 are seen to comprise a channel member 42, which extends along a length of at least one side of positioning ring 32 and preferably, on an upper surface of positioning ring 32. It will also be appreciated from the drawings that channel member 42 extends across ring 32 in an arcuate or semi-circular path. In the most preferred embodiment channel member 42 is formed by the interconnection of two separate elements, namely, an upwardly and arcuately extending sidewall 36 formed on positioning ring 32, and a toothed track 43 which is interconnected with sidewall 36. Still referring to Figure 3, in the most preferred embodiment, positioning ring 32 is seen to include the upwardly and arcuately extending sidewall 36 having a ridge 38 formed on an upper surface thereof, and extending partially if not completely along, at least one side of positioning ring 32. Further, in this preferred embodiment, the toothed track 43 is structured to be operably connected to ridge 38 by way of mating structure. For example, the mating structure can be in the form of a receiving groove disposed on the undersurface of toothed track 43, and/or by way of conventionally known fasteners 39' such as screws, rivets, etc. which may pass through positioning ring 32 at apertures 39 and extend into toothed track 43. As further illustrated in Figure 3, toothed track 43 is seen to include a lip 43' which is sized and dimensioned to protrude beyond the vertical plane formed by sidewall 36. Thus, guide means 40 in the form of a generally "C" shaped channel member 42 is comprised by the combined structure of sidewall 36 and toothed track 43, having lip 43'. It will be appreciated that toothed track 43 cooperates with the drive means 80 (see Figures 4 and 9) so as to drive the cutting head assembly 50 across positioning ring 32, as more fully discussed below.

[0033] The guide means 40 further comprise a rigid upstanding member 44 disposed on the retaining and positioning means 30, and generally opposite the toothed track 43. As will again be appreciated from the drawings, in the preferred embodiment, wherein positioning ring 32 is of a tear-drop shape, rigid upstanding member 44 comprises a post member 45 securely connected to positioning ring 32 on an upper surface thereof at or near a tip 35 thereof. From the explanation which follows, it will become clear that channel member 42 and rigid upstanding member 44 permit the cutting head assembly 50 of this invention to become effectively guided and securely received on the positioning ring 32 in two places while still permitting cutting head assembly 50 to be smoothly and slidably moved over positioning ring 32 along a generally arcuate path, by way of a pivoting motion about rigid upstanding member 44.

[0034] Referring now to Figure 2, the preferred microkeratome device is seen to include a cutting head assembly 50. A primary purpose of the cutting head assembly 50 is to house a cutting element 70 such as a cutting blade, see Figure 5, with a cutting surface operatively exposed therefrom. As such, upon the cutting

head assembly 50, with the cutting element 70 operatively disposed therein, being moved across the cornea retained within positioning ring 32, the cornea may be precisely cut by cutting element 70. To accomplish this, cutting head assembly 50 includes a main housing 51 containing the cutting element 70. Additionally, included in the main housing 51 is an aperture 58 structured and disposed to permit drive means 80 to be operably connected thereto (see Figures 4 and 9) and to thereby drive the cutting head assembly 50 across positioning ring 32 in order to effectively cut the cornea. Further, as the cutting head assembly 50 must be driven in a smooth and controlled manner across the cornea, housing 51 includes tracking means 60 which are structured and disposed for mating communication with and tracking within channel member 42, of positioning ring 32, in order to precisely guide the cutting head assembly 50, and therefore the cutting element 70, along the defined arcuate path. Finally, as a significant feature of the preferred microkeratome device is to cut a portion of the cornea without completely severing it, abutting or stop means 65 are provided, which serve the purpose of limiting and preferably, completely stopping the movement of the cutting head assembly 50 from cutting completely across the cornea, that is, before the assembly has passed completely over the cornea. The abutting or stop means are preferably disposed on the main housing 51. These features will be discussed in more detail below.

[0035] Still referring to Figure 2, the preferred microkeratome device is also seen to include a coupling member 90. Coupling member 90 is structured and disposed to movably couple the cutting head assembly 50 to the positioning ring 32 while simultaneously permitting movement of the cutting head assembly 50 relative to positioning ring 32. As illustrated in Figure 2, coupling member 90 comprises two segments: a) a retaining segment 92 and b) a pivot segment 95. The retaining segment 92 is structured and disposed to be fitted onto a top wall surface 56' of main housing 51 and may include downwardly depending flanges 91, 93 to snugly receive and grip a portion of housing 51 therebetween. The retaining segment 92 also includes an aperture 94 formed therein to correspond to aperture 58 of housing 51. As such, aperture 94 is sized and configured to allow passage of the driving shaft of the driving means 80 (shown in Figures 4 and 9) therethrough and into aperture 58 of the housing 51. Thus, in assembled form, coupling member 90 is securely yet removably coupled to head assembly 50 as a result of the engagement of the driving means 80 with the housing 51 through retaining segment 92. Turning to the pivot segment 95 of coupling member 90, it is structured and disposed to be coupled to rigid upstanding member 44 of positioning ring 32 and to permit coupling member 90, and accordingly, the cutting head assembly 50 connected thereto, to pivotally move about post member 45. Preferably, pivot segment 95 includes a bushing 97 having a bore 96 formed therein, which is sized to receive a substantial height of post

member 45, thereby captivating it therein. Further, the pivot segment 95 preferably includes maintaining means 46, see Figure 3, for maintaining rigid upstanding member 44 within bushing 97 and engagement means 98 for maintaining bushing 97 over rigid upstanding member 44. As illustrated in Figures 2 and 3, the maintaining means 46 preferably include an enlarged head 47 on rigid upstanding member 44, and an annular recess 48 or taper about the neck section of upstanding member 44. As illustrated, the engagement means 98 preferably comprise a threaded shaft which passes through a sidewall of bushing 97 and can be selectively moved into engagement with upstanding member 44 by rotating handle 99 and causing a tip thereof to extend into the annular recess 48, thereby preventing removal of the pivot segment 95 from the upstanding member 44, when surgery is to take place. It will be therefore be appreciated that in assembled form, the engagement means 98 and maintaining means 46 cooperate to permit coupling member 90 and cutting head assembly 50 to rotate about upstanding member 44 while preventing bushing 97 from sliding up and off of upstanding member 44. It will also be appreciated that in assembled form, upstanding member 44 acts as additional guide means for enabling the cutting head assembly 50 to be driven along an arcuate path in a smooth and controlled manner across positioning ring 32 and thus, the cornea C.

[0036] With reference to Figure 2, the cutting head assembly 50 of the preferred microkeratome device as well as its operation will now be described in more detail. As previously recited, the cutting head assembly 50 comprises the main housing 51 which includes a top surface 56', a bottom wall, and a surrounding sidewall structure 53 defining a front end face 52, and an oppositely disposed rear end face 54. Because during surgery, the cutting head assembly 50 is driven across positioning ring 32 along an arcuate path, front end face 52 preferably defines a tapered nose to cooperate with the arcuate path of channel member 42. Also as previously recited, the main housing is structured to contain the cutting element 70, such as a cutting blade, and to operatively expose a cutting surface thereof. In order to accomplish this, the main housing 51 is preferably structured to define an interior chamber 88, therein, see Figure 5, which is structured to receive in a cutting position and to accommodate the operation of the cutting element 70 during surgery, and preferably, of a blade cutting assembly 300, described more fully below. A cutting opening 56 is formed at a bottom of housing 51 so as to expose a cutting surface of cutting element 70, as is best illustrated in Figure 5.

[0037] Additionally, in order to permit a used cutting element 70 to be removed and replaced, housing 51 includes access means 55. In one embodiment, and as seen in Figure 5, access means 55 at least partially form bottom wall of housing 51 near rear end face 54, and ideally, comprise a door member 57 which is hinged

connected to the surrounding sidewall structure 53 at rear end face 54. Door member 57 is movable between a closed operative position for surgery and an open position for permitting a used or contaminated cutting element 70 to be removed from the housing 51 and replaced with a new or sterile cutting element. Door member 57 may be selectively maintained in the closed position by conventionally known fasteners as depicted in Figure 5. It should be noted that the door member 57 does not completely bridge the cutting element 70, which is thought to offer a sturdier and less fragile structure so as to avoid bending the cutting element when it is inserted and closed into position for use within the microkeratome.

[0038] A unique feature of the present invention, however, is to provide the cutting head assembly 50 of the microkeratome device with improved access means, see Figure 5-A, indicated generally by reference numeral 155, such that in preparation for surgery, a fresh and sterilized cutting element can be easily and quickly inserted within the cutting head assembly 50, with minimal handling so as to maintain it in a sanitary condition. Preferably, the improved access means 155 permit a fresh cutting element 70, and ideally, a cutting blade assembly 300 which includes both a cutting blade and a blade holder, described below, to be slidably inserted into the cutting head assembly, 50 and to be easily and yet properly secured in place therein in order for surgery to take place. To accomplish this, the improved access means 155 preferably comprise a side entry, access opening formed in the cutting head assembly 50. As illustrated in Figure 5-A, more preferably, the surrounding sidewall structure 53 of the cutting head assembly 50 is structured to include an access opening 156 formed therein which further, is disposed to generally correspond and align with the location of interior chamber 88 of the cutting head assembly 50, so that the cutting element 70 may be received in a proper cutting position within the cutting head assembly 50 for surgery to take place. Ideally, the access opening 156 is structured and disposed to extend completely through the cutting head assembly 50 from one side of the surrounding sidewall structure 53 to the other, so that the cutting element 70 can be easily inserted from either side of the cutting head assembly 50. It should be appreciated from the foregoing that the improved access means 155 are additionally structured and disposed to permit easy and quick removal of a used and contaminated cutting element 70 from the cutting head assembly. It should further be appreciated that while the door member 57 of the cutting head assembly 50 can also be moved to an open position so as to permit insertion of a cutting element 70 within the cutting head assembly 50, the door member is preferably only moved to the open position to permit cleaning of other internal mechanisms disposed within the cutting head, whenever needed.

[0039] With reference to Figure 5, the cutting element 70 will now be discussed. First, in the preferred embod-

iment, the cutting element 70 is disposed within the main housing 51 at about 20 to 30 degrees from the horizontal plane. Further, the cutting element 70 preferably includes a blade having a sharpened cutting edge 71, the cutting tip of which is preferably formed to have an angle of approximately and generally between 5 to 10 degrees from the horizontal axis of the blade. To accomplish these preferred goals, in a preferred embodiment, the cutting element 70 comprises a cutting blade operably connected to a blade holder 72. The blade holder is in turn, operably connected and disposed within the interior chamber 88 of the cutting head assembly 50 in communication with the drive means 80, see Figure 9, which are in turn operably coupled to the housing 51 of the cutting head assembly 50, and microkeratome generally. As has been described, the drive means 80 impart an oscillating movement to the blade holder 72, thereby causing the blade holder 72 and blade 71 connected thereto, to move back and forth within the interior chamber 88 of the cutting head assembly 50 and generally between opposite walls of the surrounding sidewall structure 53 thereof. Accordingly, the interior chamber 88 within housing 51 will be sized to receive both the cutting element, such as a cutting blade 70 and blade holder 72, and to permit the oscillating cutting movement of same within housing 51. So as to offer an improved microkeratome and cutting blade assembly that is able to cut and raise a microscopically thin layer of corneal tissue in a manner that results in very fine, smooth and almost undetectable cut corneal tissue edges, in a preferred embodiment, the drive means 80 will cause the blade holder 72 and blade 71 to oscillate at a very rapid rate, higher than that accomplished by other devices, such as generally about 5,000 to 10,000 times per minute, and ideally about 8,500 times per minute so as to offer an optimal corneal cut. Further in this regard, and as explained further below, the drive means will preferably drive the cutting head assembly 50 across the positioning ring 30 and eye held therein, at a speed which takes the cutting head assembly 50 generally between 3 to 6 seconds, and ideally about 4 or 5 seconds. These preferred ranges for the cutting speeds of the microkeratome are thought to offer optimal and markedly improved cutting of the corneal tissues.

[0040] In addition, in order to accomplish the desirable goal of easily and quickly installing the cutting element 70 within the cutting head assembly 50, without excessive handling so as to maintain sterilization, the present invention comprises a cutting blade assembly, illustrated in Figures 6 - 8 and generally indicated by reference numeral 300. The cutting blade assembly 300 of the present invention is seen to comprise an improved cutting blade 310 and blade holder 320. The cutting blade 310 comprises a front portion 312 that includes a sharp, forward cutting edge 313, a rear, trailing portion 314 having a rear edge, 315, and a pair of side edges, 316, 317 that extend and taper between the front and rear trailing portions. In a preferred embodiment, the

rear edge 315 is generally parallel to the forward cutting edge 313 of front portion 312. Also, the cutting blade 310 further includes at least one aperture, 318 formed therein, and preferably, a pair of apertures, 318 and 319 which are ideally circular in shape and disposed in the rear, trailing portion 314 in general alignment with one another. Preferably, the cutting blade 310 is substantially flat and made of stainless steel, with the front portion 312 of the cutting blade having an overall dimension which is larger than the rear trailing portion 314. In one embodiment, shown in Figure 7, the side edges 316, 317 of the improved cutting blade 310' which extend between the front portion 312 and rear trailing portion 314, are rounded. This feature readily permits the operation of the cutting assembly 300 within the preferred microkeratome device that moves along an arcuate path over the position ring 32. More specifically, the cutting blade 310' shown in Figure 7 is structured so that when it is oscillating during a surgery, wherein all or part of the blades' side edges might momentarily extend beyond the surrounding sidewall structure 53 of the cutting head assembly 50, it will not contact the positioning ring 32 nor otherwise interfere with the movement of the cutting head assembly 50 thereacross, along an arcuate path. The cutting blade 310, 310' can be formed to have other shapes to accomplish this same goal. For example, and as illustrated in Figures 6-A to 6-C, in a more preferred embodiment, the front portion 312 of the cutting blade 310 has a generally rectangular shape and the rear trailing portion 314 has a generally trapezoidal shape, such that the side edges 316, 317 thereof taper from a wider dimension of the front portion 312 to a smaller dimension in the rear trailing portion 314.

[0041] The cutting blade assembly 300 further comprises an improved blade holder 320. Blade holder 320 is formed so that an underside 321 thereof is secured to the cutting blade 310 at the at least one aperture 318 on the cutting blade, and so that a top side, 322, of the blade holder 320 includes means 325 for being operably driven by the drive means 80 of the microkeratome device. In the preferred embodiment, means 325 comprise a recess 326 formed within the blade holder, ideally having an oval shape, although the blade holder 320 could be formed to include a slot, groove or other shaped recess without departing from the scope of the present invention. Also in the preferred embodiment, the blade holder 320 will be molded of a plastic material and will be press fit during manufacture into the at least one aperture 118 on the cutting blade 310 so as to provide an integrally formed cutting blade assembly. It should be pointed out that by integrally forming the cutting blade 310 and blade holder 320, both parts which are contaminated during surgery, the cutting blade assembly 300 can be more readily removed from the cutting head 50 of the microkeratome, and further, if the blade holder 320 is formed of plastic, the cutting blade assembly 305 can be readily disposed of. Preferably, the blade holder 320 includes at least one lock segment 328 on its un-

dersurface 321, which is structured and disposed to extend through the aperture 318 formed in the cutting blade 310 so as to become secured thereto. Most preferably, the blade holder includes a pair of lock segments formed to be circular in shape and which are structured to be snugly received within the preferred pair of apertures 318, 319 formed on the blade 310. Also in the preferred embodiment, the lock segment 328 includes a flanged portion 329 which is structured to engage at least partially about an edge of the aperture formed within the blade 310.

[0042] Referring now to Figure 8, in a most preferred embodiment, the cutting blade assembly 300 of the present invention is seen to additionally comprise a tool 330 which facilitates the removal of the cutting blade 310 and blade holder 320 from a sterile packing container and the insertion thereof in a microkeratome device, while maintaining sterility. Preferably this tool is in the form of a handle assembly 360 connected to the blade holder 320 and structured to facilitate the introduction of the cutting blade assembly 300 into the access opening 156 of the cutting head assembly 50. In the preferred embodiment, the handle assembly 360 includes an elongate stem 362 structured to be threadingly coupled to the blade holder, ideally along a side wall thereof, so as to facilitate the introduction and installation of the cutting blade assembly 300 to and within the cutting head assembly 50. If desired, in this embodiment or in other embodiments, the handle assembly can be structured to permit the elongate stem 362 to be reconnected with the blade holder so as to remove a contaminated cutting blade assembly from the cutting head assembly 50, following a surgery. In an alternative preferred embodiment, the handle assembly 360 may include an elongate stem integrally formed with the blade holder and structured to be separated therefrom upon introduction and installation of the cutting blade assembly within the cutting head assembly 50. It should be appreciated that in this alternative preferred embodiment, the handle assembly may be comprised of a suitable plastic material so that it can be integrally formed with the preferred blade holder 320, and the entire cutting blade assembly can then be readily packaged in containers that permit sterilization prior to shipping, and which remain sterilized during shipping. In this way, the handle assembly 360 with the cutting blade assembly 300 connected thereto, can be easily removed from the sterile packaging and the handle assembly 360 used to quickly and easily insert the cutting blade assembly 300, while maintaining it in a sanitary condition, into the microkeratome's cutting head assembly, 50. Thereupon, the handle assembly 360 can be broken off from the cutting blade assembly 300 and discarded or otherwise disposed of.

[0043] Referring back now to Figure 5, other features of the preferred microkeratome device will be described. In the preferred embodiment, the housing 51 of cutting head assembly 50 will include depth adjusting means

75 for adjusting the depth at which cutting element 70 cuts into the cornea. As illustrated in Figure 5, the depth adjusting means 75 are preferably disposed at the front end face 52 of main housing 51 and form at least a portion of the bottom wall of housing 51 near front end face 52. Preferably, the depth adjusting means 75 comprise a separate nose segment 76, which is structured to be securely, yet removably interconnected with housing 51 by way of a conventionally known fasteners 74 such as a screw, a bolt, etc. Preferably, the nose segment 76 comprises an engagement segment 77 and a variable depth plate member 78. Engagement segment 77 preferably includes a terminal end 79 which is formed to define an inverted "V" shape, and preferably extends across the width of the nose segment 76. This structure is sized and configured to be received and to nest within a corresponding void, also shaped like an inverted "V", formed within housing 51 on and between oppositely disposed sidewall structures 53, adjacent front end face 52. It will be appreciated that this structure permits a highly stable nesting or dwelling of terminal end 79 within housing 51 even as the cutting head assembly 50 is moved along an arcuate path over positioning ring 32. Further, as illustrated, variable depth plate member 78 is preferably integral with engagement segment 77 and is disposed substantially in the horizontal plane. Variable depth plate member 78, has a depth depicted as "H" in Figure 5, which is a dimension pre-selected by the surgeon to correspond the desired depth of the cut to be made into the cornea. Another feature is to provide a plurality of nose segments 76, each including a plate member 78 having a differently dimensioned depth "H". It will be appreciated from Figure 5 that there is an inverse relationship between the depth of plate member 78 and the depth of the cut to the cornea as the cutting head assembly 50 proceeds forward during surgery in the direction of the arrow "A" and pushes down on the cornea. For example, a plate member 78 having a larger depth "H" will shield more of the blade's cutting edge 71 whereas a plate member 78 having a smaller depth "H" will expose more of area above the blade's cutting edge. It will thus be recognized that the cutting head assembly 50 is designed to be interchangeable with differently sized depth adjusting means 75 so as to precisely meet the needs of the patient undergoing surgery. Ideally, there are two differently sized nose segments 76, namely one sized for 130 microns and another for 160 microns which are currently the most desirable depths for cutting into the cornea and exposing same for reshaping.

[0044] As has been described, housing 51 of cutting head assembly 50 also includes tracking means 60. Referring to Figure 2, tracking means 60, which in the preferred embodiment are disposed on a lower peripheral zone of housing 51, are structured for mating communication with and tracking within channel member 42, see Figure 3, of positioning ring 32. For example, in the preferred embodiment the tracking means 60 are disposed on the depth adjusting means 75 and are integral

with and planar to the variable depth plate member 78 in the form of a flange 62, see Figure 2. Preferably, flange 62 extends out beyond the periphery defined by surrounding sidewall 53 of housing 51 in generally perpendicular relation thereto. Further, although the cutting head assembly 50 is designed to receive nose segments 76 having variable depth plate members 78, flange 62 which extends therefrom is of a uniform height so as to correspond and effect mating communication with and tracking within channel member 42, of positioning ring 32. Although flange 62 could extend only from one side of the housing 51, in the preferred embodiment, flange 62 is disposed on each side of variable depth plate member 78, thereby facilitating use of the present invention on either a patient's left or right eye.

[0045] Also as previously recited, the main housing 51 includes abutting or stop means 65 which serve the purpose of limiting and preferably stopping, the forward movement of cutting head assembly 50 across positioning ring 32. In the preferred embodiment, stop means 65 are formed generally at rear end face 54 on surrounding sidewall structure 53 and are seen to comprise a shoulder 66 formed at the juncture between sidewall structure 53 and rear end face 54 of the housing 51, which shoulder is sized to be too large to pass within the channel member 42 of the guide means 40, thereby preventing any further forward motion of the head assembly 50 across positioning ring 32. When abutting engagement occurs between shoulder 66 and channel member 42, by way of lip 43', the driving means 80 can be stopped and then reversed to permit movement of the cutting head assembly 50 in the opposite direction. As has been described, it has been determined in recent years that in performing surgery on the cornea, the layers of the cornea which are cut should not be completely severed. A unique feature of the cutting head assembly 50 and of this invention 10 is that the cutting of the cornea, C, results in the formation of a corneal flap F, as illustrated in Figure 1, which is also safely preserved by the assembly 50. To preserve the corneal flap F, housing 51 includes a flap receiving gap 59 formed within housing 51. As illustrated in Figure 2 and more clearly in Figure 5, flap receiving gap 59 is disposed generally near the front end face 52 of housing 51 and more particularly, is defined by a gap formed just forward of the blade's cutting edge 71 and just rearward of variable depth plate member 78. Thus, flap receiving gap 59 is disposed on an undersurface of housing 51 and extends upwardly and into housing 51. Ideally, flap receiving gap 59 extends through the opposite sidewall structure 53 of housing 51.

[0046] In preparation for cutting the cornea with the preferred microkeratome device: a) a sterilized improved cutting blade assembly 300 is slidably moved into position within the cutting head assembly 50, and b) the coupling member 90 is mounted on the cutting head assembly 50 and the drive means 80 connected to and engaged therewith. Referring to Figure 2, as an addi-

tional feature, the cutting head assembly 50 may include indicia 67 for indicating to a surgeon which eye the device is in position to cut. For example, it is preferred that indicia such as the letter "L" as an abbreviation for "Left" or "left eye" and the letter "R" as an abbreviation for "Right" or "right eye" be utilized, or their equivalents in words or abbreviations in a foreign language or symbols. This indicia will preferably appear on opposite sides of the surrounding side wall structure 53 of the main housing 51 of the cutting head assembly 50, in a location which will be selectively concealed by the coupling member 90. In particular, when operably coupled with the cutting head assembly 50 and disposed over so as to cut the right eye, the coupling member 90 extends down the left side of the main housing 51 of the cutting head assembly 50, leaving only the right side, and preferred "R" indicia positioned thereon, visible. Conversely, when assembled to cut the left eye, the coupling member 90 extends down the right side of the housing 51, leaving only the left side and the indicia positioned thereon readily visible. As such, it is seen that a further safety feature directed towards ensuring proper alignment of the device on a patient's eye is achieved.

[0047] To continue, once the positioning ring 32 has been centered on the eye with a proper vacuum applied to temporarily attach it thereto, c) the tracking means 60 of the head assembly 50 can be matingly connected to the guide means 40 of positioning ring 32 in an initial or start position. Once power is supplied to the microkeratome device, the cutting head assembly 50 may move across the positioning ring 32 with cutting of the cornea C, taking place until the stop means 65 contact channel member 42 of the positioning ring 32, to limit and preferably, prevent any further forward motion of the assembly. It should also be clear that in this stopped position, the cutting element 70 has not moved completely across the cornea C, but rather has cut a portion of the cornea up until this point, creating a corneal flap which is left attached to the cornea as designated by the area marked "F" which is shown in the Figures 10-A and 10-B. Moreover, as illustrated in Figure 5, the corneal flap created has been directed by the forward movement of the assembly, upwardly and into flap receiving gap 59 of housing 51 to be preserved and kept clear of cutting element 70. Once the assembly has been stopped as in Figure 10-B, the drive means 80 can be reversed to permit movement of the cutting head assembly 50 in the opposite direction, which does not result in any further cutting of the cornea, but rather, in the safe removal of the corneal flap F out of flap receiving gap 59 of housing 51. Thus, when the cutting head assembly 50 returns through to a position analogous to that shown in Figure 10-A, it can be disengaged from the retaining means 30. The corneal flap F can then be maneuvered so as to permit the cornea to be reshaped, preferably by way of a laser surgical procedure. Once the surgery has been completed, the corneal flap is returned to a covering relation over cornea.

[0048] Another unique feature of the present invention is not only that a corneal flap can be created, but significantly, that the corneal flap is positioned in such a way that the blinking of the eye will not improperly position the corneal flap on the cornea following surgery. Referring again to Figures 10-A and 10-B, the preferred microkeratome device is schematically illustrated on both a patient's left and right eyes. As depicted in Figure 10-A, reference points of the work environment can be equated with the position of some numerals on the face of a clock. Thus, in Figure 10-A, it will be noted that with respect to the patient's left eye, the cutting head assembly 50 in the initial position is preferably disposed at a generally five o'clock position. With respect to the patient's right eye, the cutting head assembly 50 in the initial position is preferably disposed at a generally seven o'clock position. Turning now to Figure 10-B, the cutting head assembly 50 is shown to have moved towards a position generally aligned with the twelve o'clock position, wherein the stop means 65 are in abutting engagement with channel member 42 of the positioning ring 32, such that any further forward motion of the assembly is prevented. It will thus be appreciated that regardless of whether the surgical procedure is being performed on a patient's left or right eye, the cutting head assembly 50 is preferably aligned generally with a twelve o'clock position. It will also be appreciated from Figure 10-B that the resulting corneal flap F, remains attached to the cornea at an upper region thereof. As a result, following the surgical procedure to reshape the cornea, the orientation of the corneal flap will be in generally the same direction as the natural blinking action. That is, it is believed that the downward blinking motion of the patient will tend to stroke the corneal flap down and thereby assist with maintaining the corneal flap in proper re-position on the cornea so as to avoid the development of astigmatism.

[0049] Referring now to Figure 9, the present invention includes drive means 80 both: a) for driving the cutting head assembly 50 across the previously described eyeball retaining and positioning means 30; and b) for causing the cutting element 70 to oscillate back and forth within housing 51. The drive means 80 in a most preferred embodiment will drive the cutting head assembly 50 across the eyeball retaining and positioning means 30 and eye held therein, at a speed which takes the cutting head assembly generally between 3 to 6 seconds in the first direction, and similarly in the opposite direction. Also, in a preferred embodiment, the drive means 80 include among other items, discussed below, a motor 100, which is electrically operated and more preferably, a micromotor capable of operating at a constant and uniform speed, regardless of the load. Specifically, under normal circumstances the natural resistance encountered by the cutting head assembly 50, as it is driven over the cornea, would result in an increased resistance in the winding of the micromotor, which would tend to cause a voltage drop and therefore a drop in

speed. While some known systems for microkeratome devices attempt to avoid excessive drops in speed by incorporating an overpowered motor to keep losses below a 10% slow down, the motor 100 is preferably equipped to monitor current flowing therethrough, such as by using an op amp, and to utilize that information to control the applied voltage and maintain a generally constant speed. This monitoring and compensation, sometimes referred to as I R compensation, thereby permits a conventional, regulated 12 V supply to be used with a DC motor in order to maintain the effective constant speed of travel of the cutting head assembly 50 over the eye.

[0050] Referring now to Figure 4 and again to Figure 9, the driving means 80 of the microkeratome device are seen in the preferred embodiment to further include a gear box 81 into which a motor main drive shaft 101 extends. From the gear box 81, and specifically concentrically through an engagement hub 110 as shown in Figures 4 and 5, a cutting assembly main drive shaft operatively extends. The cutting assembly main drive shaft comprises two primary sections, namely: a) a threaded drive screw or "worm" 115 shown in Figure 9, which is an intermediate section that extends through the engagement hub 110; and b) an oscillation shaft 130, also shown in Figure 9, and which is the inner most section and extends through the worm 115.

[0051] Turning first to the engagement hub 110, shown in Figure 4, it is an outer most section that preferably extends downwardly from the gear box 81 and is structured to be matingly, and preferably threadingly engaged within the threaded aperture 58 formed in the main housing 51. As such, the engagement hub 110 functions to secure the drive means 80 to the cutting head assembly 50. Further, it will be recognized that the drive means 80 are thereby permitted to enter the cutting head assembly 50 through a top surface 56' and are thus, generally vertically disposed. It is believed that this feature results in less interference with the surgical field and facilitates finer handling by the surgeon than is offered by conventionally known microkeratomes. Specifically, known microkeratomes have typically provided for horizontally disposed drive means, which resulted in the surgeon having to handle a cord of the driving means, which if not held properly could cause drag on the operation of the microkeratome and/or result in a different pressure being applied to the microkeratome. Moreover, the structure of the present invention maintains its center of gravity substantially over the center of the eye, unlike old systems, thereby providing increased balance and ensuring that the cutting head assembly does not inadvertently tip away from the surface of the eye during use.

[0052] As illustrated in Figure 5, the oscillation shaft also extends from the gear box 81. Turning now to Figure 9, the oscillation shaft 130, which extends into the housing 51 through its aperture 58, is preferably an independent element that extends concentrically through

and protrudes from both ends of the worm 115. The oscillation shaft 130, which is preferably structured to freely rotate relative to the worm 115 includes an upper drive portion 132 which may be welded onto shaft 130 but which is in any event, drivingly engaged with a main drive gear 102 secured to the motor main drive shaft 101. Accordingly, rotation of the motor main drive shaft 101 results in corresponding rotation of the oscillation shaft 130. Further, protruding off center from an opposite end 134 of the oscillation shaft 130 is an oscillation pin 135. The oscillation pin 135, which is preferably downwardly biased to maintain engagement pressure on the cutting element 70 is structured to extend into a slot 72' formed in an upper surface of the preferred blade holder 72 or other means 325 formed on the blade holder for receiving the oscillating pin and permitting it to impart movement thereto. As such, upon axial rotation of the oscillation shaft 130, the oscillation pin 135 rotates a predetermined radius off center and alternately engages opposite side edges of the slot 72' of the blade holder 72 to result in alternating, oscillating movement of the blade holder 72 and the cutting blade held thereby.

[0053] Still referring to Figure 9, the oscillating shaft 130 further includes a secondary drive portion 133. The secondary drive portion 133 is drivingly connected with a first interior drive gear 103 contained within the gear box 81. The first interior drive gear 103 is connected with and drivingly secured to an interior drive shaft 104, which preferably includes a second interior drive gear 105 disposed thereon in spaced apart relation from the first interior drive gear 103. As such, upon rotation of the oscillation shaft 130, the second interior drive gear 105 also rotates.

[0054] Again with reference to Figure 9, drivingly connected with the second interior drive gear 105 and structured to extend from an interior of the gear box 81, concentrically through the engagement hub 110, is the threaded drive screw or "worm" 115. The worm 115, which extends up into the gear box 81 includes a drive head 116 which engages the second interior drive gear 105. As a result, upon rotation of the interior drive shaft 104, the worm 115 correspondingly rotates within the housing 51 of the cutting head assembly 50. Further, rotatably disposed within the housing 51, in operative engagement with the worm 115, is a worm gear 120. The worm gear 120 preferably includes an increase diameter central portion 122 having a plurality of drive recesses formed about a perimeter thereof and structured to engage the exterior threaded surface of the worm 115 such that the central portion 122, and accordingly the entire worm gear 120, rotates about a horizontal axis as a result of the rotation of the worm 115 about a vertical axis. It is noted that the screw-like threaded surface of the worm 115 enables the worm 115 to rotate without moving vertically and successively engage the drive recesses on the worm gear 120 to effect rotation thereof. Extending from at least one, but preferably both vertical faces of the central portion 122 of the worm gear 120 is

a propulsion shaft 125. The propulsion shaft 125, which comprises additional tracking means, is structured to protrude from the sidewall structure 53 of the main housing 51 and engage the toothed track 43 on the positioning ring 32 such that upon rotation of the worm gear 120, and accordingly rotation of the propulsion shaft 125, the propulsion shaft 125 rides along the toothed track 43 and drives the cutting head assembly 50 across the positioning ring 32 smoothly and at a steady and defined pace. Furthermore, it is seen that by reversing the rotational direction of the interior drive shaft 101 within the gear box 81, the direction of rotation of the worm 115 and therefore the worm gear 120 are reversed to effectuate reverse driven movement of the cutting head assembly 50 over the positioning head 32. Also, so as to facilitate movement over toothed track 43 and the arcuate path thereof, it is preferred that the propulsion shaft 125 portion of the worm gear 120 include a helical gear configuration or plurality of angled ridges to permit more effective alignment with the curved toothed track 43 and movement thereover.

[0055] Considering the motor 100, once again, it is preferred that it be controlled by a foot pedal or like actuation means. In the case of a foot pedal, it is preferred that it be a dual function foot pedal such that one side will function to drive the motor main drive gear 101, and therefore the cutting head assembly 50 in a forward direction, and the second side will drive them in a reverse direction. Further, the system may be set to a manual mode whereby a doctor must affirmatively reverse the direction of movement, or an "auto-reverse" mode wherein upon the cutting head assembly 50 traveling its maximum distance it automatically reverses direction. In either case, however, the motor 100 will preferably be equipped with a sensor to detect an abrupt current increase. Specifically, when the cutting head assembly 50 reaches the stop means 65 and further forward movement is either partially or completely resisted, an abrupt current increase will occur in the motor 100. That abrupt current increase, once detected, can signal either the power to shut off, or the reverse movement to commence, depending upon a doctor's desired setting.

[0056] As has been described, the preferred microkeratome device can be utilized on both eyes of the patient, see Figure 10-A and 10-B. Specifically, as worm gear 120 runs through housing 51 and juts out of the opposite surrounding sidewall structure 53 of housing 51, the cutting head assembly is ready to use on the opposite eye of a patient. In order to accomplish this, and due to the symmetric shape of the cutting head assembly 50, the drive means 80 need only be removed from the housing 51 and thus, coupling member 90, whereupon, it can be re-oriented 180 degrees for use with the opposite eye of a patient.

[0057] Considering the drive means 80 once again, it should be noted that they must generally operate in conjunction and in harmony with the suctioning means applied to the positioning ring 32 when surgery is per-

formed on an eye. Both the drive means 80 and the suctioning means are part of an overall control assembly 200. The control assembly 200 includes a portable housing 205 from which power and control is supplied through a cable 203 to the portion of the drive means 80 which interact with the cutting head assembly 50, and from which a vacuum source of the suctioning means is supplied through the vacuum hose 202. The suctioning means and the vacuum source which it provides will be addressed first. Specifically, the vacuum source generally includes a vacuum pump 210 contained within the housing 205 which is powered by a conventional power supply and which operates to create the vacuum which results in a suction at the positioning ring. In addition to the vacuum pump 210, however, the suctioning means further include a reserve vacuum tank 215. The reserve vacuum tank 215 is structured to be filled upon activating the control assembly 200. Moreover, in the event that the operation of the vacuum pump is interrupted, such as due to a power loss, the reserve vacuum tank 215 is preferably structured to be immediately available to generate a sufficient vacuum to maintain the positioning ring's hold on the eye until the movement of the cutting head assembly 50 over the eye is completed. Specifically, the control assembly 200 is structured to automatically activate the reserve vacuum tank 215 in the event of a power loss or other interruption to the operation of the vacuum pump 210, and therefore, a complete cutting pass across the eye does not have to be dangerously and unexpectedly interrupted due to an interruption in the operation of the vacuum pump 210.

[0058] The vacuum pump 210 is preferably controlled by a computerized processor control 220 within the housing 205. The processor control 220 functions primarily when the control assembly 200 is turned on and/or is in a "Ready" mode. In particular, when the control assembly 200 is first turned on, it is structured to conduct a number of internal tests, as indicated on a display screen 211, and the vacuum pump 210 is preferably directed to first generate a vacuum in the reserve vacuum tank 215. Next, the vacuum pump 210 will preferably continue to run until a desired vacuum relative to atmospheric pressure is generated. Once the desired vacuum is achieved, however, operation of the vacuum pump is cycled. For example, once a desired level is attained, the vacuum pump 210 is turned off until the vacuum drops below a certain point relative to atmospheric pressure. At that point, the vacuum pump 210 is preferably turned on once again by the processor control 220 in order to raise the vacuum back up above the desired level. In this manner, an operable, back-up vacuum is available, if ever it should be needed.

[0059] In the preferred embodiment, the control assembly 200 remains in the "Ready" mode until a user wishes to begin an operation or to conduct further testing, if that is desired. When, however, it is time to begin an operation, a user typically presses a foot pedal 216 or other switch to activate the vacuum and shift the con-

trol assembly into an "Operating" mode. Before entering the "Operating mode, a "Pre-op" mode is preferably initiated wherein the control assembly 200 completes a number of internal tests. Unlike the "Ready" mode, once in the "Operating mode, the vacuum pump 210 will preferably remain on, thereby ensuring that a sufficient vacuum will always be present. Furthermore, so as to ensure that a malfunction in the processor control 220 does not affect the vacuum generated, once the "Operating" mode is entered, control of the vacuum pump is removed/interrupted from the processor control 220 and is transferred to an independent logic control 225, such as to one or more PAL chips. Preferably, this transfer of control is achieved utilizing a latching switch 228 connected between the processor control 220 and the independent logic control 225. The latching switch 228 is normally positioned to connect the processor control 220 with the vacuum pump 210, however, when the "Operation" mode is entered, it is switched over to achieve a connection with and thereby activate the independent logic control 220. Preferably, this connection with the independent logic control 220 is maintained until affirmatively reset by a user. For example, a reset switch 229 may be provided on the housing 205 to reset the latching switch 228.

[0060] Still addressing the suctioning means, although the powering of the vacuum pump 210 requires a high voltage, it, as well as all other high voltage aspects of the control assembly 200, must be isolated from a low voltage portion of the housing 205 which comes into contact with the patient. In this regard, in some instances a momentary loss of power to the vacuum pump 215 can sometimes result, thereby requiring a resetting of conditions before normal operation can proceed. For example, if the current jumps from approximately .6 amps to approximately 1.3 amps, the control assembly will preferably identify a "pump stall" and activate a warning signal. If the "pump stall" is identified as being continuous, the vacuum reserve tank is preferably triggered to immediately maintain the vacuum so as to enable a surgery in progress to be completed. If, however, the "pump stall" is identified to be only momentary, normal operation of the vacuum pump may be able to proceed. However, even if the stall is only momentary, the vacuum pump will typically not resume operation if a full vacuum is still present, thereby requiring a momentary release of vacuum prior to its resuming operation. The release of vacuum, however, must take place on the low voltage side of the control assembly 200. Therefore, an optic coupler 240 is preferably utilized to trigger the momentary release of vacuum. In particular, when the previously described, typical current jump associated with a "pump stall" is exhibited, that current jump passing through a preferably .75 ohm resistor 241 is sufficient to trigger an LED 242 of the optic coupler 240. The LED 242, preferably through a pulse extender 243, then preferably triggers a confrontingly positioned semi-conductor chip 245 that actuates a valve 247 to cause the mo-

mentary release in vacuum required for the continuing operation of the vacuum pump 210. Accordingly, complete isolation is maintained between the high voltage and low voltage sides of the assembly.

[0061] Turning now to the other aspect affected by the control assembly 200, namely, the drive means 80, they are preferably powered by a motor 250 contained within the control assembly 200. The motor 250 is sufficient to drive the cutting head assembly 50 across a positioning ring, such as 32, and will preferably operate in both a forward and a reverse direction. Furthermore, so as to prevent motor overload and/or burn out, the control assembly 200 is structured to detect an increase in amperage above a certain predetermined limit, preferably at least a 300 milliamp level, which is a typical indication that movement of the cutting head assembly 50 has stopped and that the activity of the motor and drive means is being resisted. A stop of the cutting head assembly 50 can occur either due to the presence of an obstacle on the cutting path over the positioning ring, such as a number of eyelashes or other debris, or due to the normal stopping of the cutting head assembly 50 because it has made a complete cut. In any event, however, if the motor 250 pulls to the at least a 300 milliamp level for a continued period of time, preferably approximately 3 seconds, the motor shuts off until reset by a user. To reset, a user may temporarily remove pressure from the foot pedal 252 so as to reset and then again activate the foot pedal to result in a continued movement of the motor 250 until another amperage increase is detected for another 3 seconds. In the preferred embodiment, such a timed amperage increase is only detected in a forward direction and not a reverse direction. Rather, a more absolute limit of preferably approximately 400 milliamperes is set to stop movement in either a forward or reverse direction.

[0062] In addition to stopping the operation of the drive means 80 because of a movement stoppage, in the event of a loss of suction at the positioning ring, which may result in temporary or complete detachment of the positioning ring from the eye, the control assembly 200 is preferably further structured to immediately shut off the motor 250, and therefore, the drive means. As a result, the cutting head assembly 50 will not continue to cut if the positioning ring becomes loose about the eye or otherwise is not properly attached temporarily to the eye. Moreover, if such a shut down occurs, complete re-initiation of the operating mode, including the normal array of systems checks and the reestablishment of the vacuum, must preferably be achieved before operation of the motor 250 can resume.

[0063] As indicated, the vacuum pump 210 preferably includes a backup, in the form of the vacuum reserve tank 215, that will operate if the vacuum pump 210 fails, such as due to a power loss. Similarly, the motor 250 preferably includes a backup power source 260, such as one or more lithium batteries, disposed within the housing 205 of the control assembly 200. The backup

power source 260 is most preferably included within and as part of the control assembly 200 and functions to immediately continue to supply operating power to the motor 250 in case of a power loss from a typical power supply. As such, a completed pass across the eye can be completed if a power failure occurs, and removal and or re-initiation of the cutting head assembly 50 need not occur in mid-cut.

[0064] Lastly, it is noted that in some instances a user that is monitoring patient conditions may not be able to easily view the display screen 211 of the control assembly 200, especially if they are already viewing a larger computer display console that monitors other patient conditions. As such, the control assembly 200 includes a connection port 265, such as a serial connection port, through which a computer interface can be achieved and through which data relating to the operation of the control assembly 200 can be transmitted for convenient use and display on the larger computer display console.

[0065] Since many modifications, variations and changes in detail can be made to the described preferred embodiment of the invention, it is intended that all matters in the foregoing description and shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense. Thus, the scope of the invention should be determined by the appended claims and their legal equivalents.

Claims

1. A cutting blade assembly (300) to be used with a surgical device that cuts at least partially across a cornea of an eye of a patient, the surgical device including a drive means said cutting blade assembly comprising:

a) a cutting blade (310) having:

- i) a front portion (312), said front portion including a sharp, forward cutting edge (313);
- ii) a rear, trailing portion (314) including a rear edge (315);
- iii) a pair of side edges (316, 317) interconnecting said front portion and said rear trailing portion; and

b) a blade holder (320) being operably connected to said cutting blade (310) and structured to be operably driven by the drive means of the surgical device, characterized in that said side edges (316, 317) of said cutting blade (310) being at least partially tapered between said front portion (312) and said rear trailing portion (314).

2. A cutting blade assembly as recited in claim 1,

wherein said pair of side edges (316, 317) extending between said front portion (312) and rear trailing portion (314) are rounded.

3. A cutting blade assembly as recited in claim 1 or 2, wherein said cutting blade (310) is substantially flat. 5
4. A cutting blade assembly as recited in any of claims 1 to 3, wherein said blade holder (320) is formed substantially of a plastic material so as to be disposable. 10
5. A cutting blade assembly as recited in any of claims 1 to 4, wherein said rear edge (315) of said rear portion (314) of said cutting blade (310) is generally parallel to said forward cutting edge (313) of said front portion (312) of said cutting blade (310). 15
6. A cutting blade assembly as recited in any of claims 1 to 5, wherein said front portion (312) of said cutting blade (310) is larger than said rear, trailing portion (314). 20
7. A cutting blade assembly as recited in any of claim 1, 3 to 6 wherein 5 said front portion (312) of said cutting blade (310) has a generally rectangular shape and said rear, trailing portion (314) of said cutting blade (310) has a generally trapezoidal shape. 25
8. A cutting blade assembly as recited in any of claims 1 to 7, wherein said cutting blade (310) comprises at least one aperture (318) formed therein. 30
9. A cutting blade assembly as recited in claim 8, wherein said cutting blade (310) is formed to include at least a second aperture (319) formed therein, said apertures (318, 319) including a generally circular configuration. 35
10. A cutting blade assembly as recited in claim 8 or 9, wherein said aperture (318, 319) formed within said cutting blade (310) is disposed in said rear, trailing portion (314) of said cutting blade and has a generally circular shape. 40
11. A cutting blade assembly as recited in any of claims 8 to 10, wherein said rear, trailing portion (314) of said cutting blade (310) includes a pair of said apertures (318, 319) formed therein and disposed in substantially aligned relation with one another. 45
12. A cutting blade assembly as recited in any of claims 8 to 11, wherein said blade holder (320) has an underside, said underside of said blade holder is secured to said cutting blade (310) at said at least one aperture formed in said cutting blade, and a top side (322) of said blade holder comprises means for be-

ing operably driven by the drive means.

13. A cutting blade assembly as recited in claim 12, wherein said means on said blade holder (320) for being operably driven by the drive means comprise a recess (325) formed within said blade holder.
14. A cutting blade assembly as recited in claim 13, wherein said recess (326) in said blade holder (320) is generally oval shaped.
15. A cutting blade assembly as recited in any of claims 8 to 14, wherein said blade holder (320) includes a lock segment (328) structured to extend through said aperture (318) in said cutting blade (310).
16. A cutting blade assembly as recited in claim 15, wherein said lock segment (328) includes a flanged portion (329) structured to engage an edge of said aperture (318) formed in said cutting blade (310).
17. A cutting blade assembly as recited in any of claims 1 to 16, wherein said sharp, forward cutting edge (313) of said cutting blade (310) is formed to have an angle of approximately between five to ten degrees from a horizontal axis of said cutting blade (310).
18. A cutting blade assembly as recited in any of claims 1 to 17 further including a handle assembly (360) removably connected to said blade (310, 320) unit and structured to facilitate introduction of said blade unit into an access opening (156) of a cutting head assembly (50).
19. A cutting blade assembly as recited in claim 18 wherein said handle assembly (360) is structured to be reconnected with said blade unit (310, 320) so as to facilitate removal of said blade unit from the cutting head assembly (50).
20. A cutting blade assembly as recited in claim 18 or 19 wherein said handle assembly (360) includes an elongate stem (362) structured to be threadingly coupled to said blade holder (320) along a side wall thereof.
21. A cutting blade assembly as recited in claim 18 or 19 wherein said handle assembly (360) includes an elongate stem (362) integrally formed with said blade holder (320) and structured to be separated therefrom upon introduction of said blade holder in the cutting head assembly (50).
22. A medical apparatus comprising
a cutting blade assembly as recited in any of claims 1 to 21 and
a surgical device for cutting substantially

across a cornea of an eye of a patient, said device comprising:

- a) a positioning ring (32) having means for temporary attachment to a portion of the eye surrounding the cornea to be cut; said positioning ring (32) defining an aperture (33) sized to receive and expose the cornea to be cut;
- b) said positioning ring including guide means (40) formed on a upper surface thereof in a generally arcuate path;
- c) a cutting head assembly (50) including said cutting blade assembly (300) positioned therein for cutting the cornea, said cutting head assembly being structured and disposed to be driven across said positioning ring (32) along said generally arcuate path defined by said guide means (40);
- d) drive means (80) operably coupled to said cutting head assembly (50) for causing movement of said cutting head assembly across said positioning ring (32) and for causing oscillating movement of said cutting blade assembly (300);
- e) said cutting head assembly (50) further comprising a main housing (51) including a top surface (56') and a bottom surface, a front end face (52) and a rear end face (54), a surrounding sidewall structure (53) between said surfaces and faces, an interior chamber (88) structured to receive and maintain said cutting blade assembly (300) in a cutting position, and a cutting opening (56) formed in said bottom surface for exposing a cutting surface of said cutting blade assembly.

- 23. A medical apparatus according to claim 22, wherein said surrounding sidewall structure (53) includes an access opening (156) formed therein and disposed to generally correspond said interior chamber (88) so that at least said cutting element can be easily inserted and removed from said housing (51).
- 24. A medical apparatus according to claim 23, wherein said access opening (156) is structured and disposed to extend completely through said surrounding side wall structure (53) of said cutting head assembly (50) from one side to another.

Patentansprüche

- 1. Schneidklingenanordnung (300) zur Verwendung mit einer chirurgischen Vorrichtung, die zumindest teilweise durch eine Hornhaut eines Auges eines Patienten schneidet, wobei die chirurgische Vorrichtung die Schneidklingenanordnung aufweist,

mit:

a) einer Schneidklinge (310) mit:

- i) einem vorderen Abschnitt (312), wobei der vordere Abschnitt eine scharfe, vordere Schneidkante (313) aufweist;
- ii) einem rückseitigen, hinteren Abschnitt (314) mit einer Hinterkante (315);
- iii) einem Paar Seitenkanten (316, 317), die den vorderen Abschnitt und den rückseitigen, hinteren Abschnitt miteinander verbinden; und

b) einem Klingenhalter (320), der mit der Schneidklinge (310) betriebsfähig verbunden ist und so strukturiert ist, daß er von der Antriebseinrichtung der chirurgischen Vorrichtung betriebsfähig angetrieben werden kann, **dadurch gekennzeichnet, daß** die Seitenkanten (316, 317) der Schneidklinge (310) sich zwischen dem vorderen Abschnitt (312) und dem rückseitigen, hinteren Abschnitt (314) zumindest teilweise verzängen.

- 2. Schneidklingenanordnung nach Anspruch 1, wobei das Paar Seitenkanten (316, 317), die sich zwischen dem vorderen Abschnitt (312) und dem rückseitigen, hinteren Abschnitt (314) erstrecken, abgerundet sind.
- 3. Schneidklingenanordnung nach Anspruch 1 oder 2, wobei die Schneidklinge (310) im wesentlichen flach ist.
- 4. Schneidklingenanordnung nach einem der Ansprüche 1 bis 3, wobei der Klingenhalter (320) im wesentlichen aus einem Kunststoffmaterial besteht, so daß er nach Gebrauch wegwerfbar ist.
- 5. Schneidklingenanordnung nach einem der Ansprüche 1 bis 4, wobei die hintere Kante (315) des hinteren Abschnitts (314) der Schneidklinge (310) im allgemeinen parallel zu der vorderen Schneidkante (313) des vorderen Abschnitts (312) der Schneidklinge (310) ist.
- 6. Schneidklingenanordnung nach einem der Ansprüche 1 bis 5, wobei der vordere Abschnitt (312) der Schneidklinge (310) größer ist als der rückseitige, hintere Abschnitt (314).
- 7. Schneidklingenanordnung nach einem der Ansprüche 1, 3 bis 6, wobei der vordere Abschnitt (312) der Schneidklinge (310) eine im allgemeinen rechteckige Form hat und der rückseitige, hintere Abschnitt (314) der Schneidklinge (310) eine im allgemeinen trapezartige Form hat.

8. Schneidklingenanordnung nach einem der Ansprüche 1 bis 7, wobei die Schneidklinge (310) zumindest eine darin ausgebildete Öffnung (318) aufweist.
9. Schneidklingenanordnung nach Anspruch 8, wobei die Schneidklinge (310) so ausgebildet ist, daß sie mindestens eine darin ausgebildete zweite Öffnung (319) aufweist, wobei die Öffnungen (318, 319) eine im allgemeinen kreisförmige Konfiguration aufweisen.
10. Schneidklingenanordnung nach Anspruch 8 oder 9, wobei die in der Schneidklinge (310) ausgebildete Öffnung (318, 319) in dem rückseitigen, hinteren Abschnitt (314) der Schneidklinge ausgebildet ist und eine im allgemeinen kreisförmige Form hat.
11. Schneidklingenanordnung nach einem der Ansprüche 8 bis 10, wobei der rückseitige, hintere Abschnitt (314) der Schneidklinge (310) ein Paar der darin ausgebildeten Öffnungen (318, 319) aufweist, die in einer im wesentlichen ausgerichteten Beziehung zueinander angeordnet sind.
12. Schneidklingenanordnung nach einem der Ansprüche 8 bis 11, wobei der Klingenhalter (320) eine Unterseite hat, wobei die Unterseite des Klingenhalters an der Schneidklinge (310) an der zumindest einen in der Schneidklinge ausgebildeten Öffnung fest angeordnet ist und eine Oberseite (322) des Klingenhalters eine Einrichtung aufweist, die dazu dient, von der Antriebseinrichtung betriebsfähig angetrieben zu werden.
13. Schneidklingenanordnung nach Anspruch 12, wobei die Einrichtung an dem Klingenhalter (320), die dazu dient, durch die Antriebseinrichtung betriebsfähig angetrieben zu werden, eine in den Klingenhalter ausgebildete Vertiefung (326) aufweist.
14. Schneidklingenanordnung nach Anspruch 13, wobei die Vertiefung (326) in dem Klingenhalter (320) im allgemeinen oval geformt ist.
15. Schneidklingenanordnung nach einem der Ansprüche 8 bis 14, wobei der Klingenhalter (320) ein Verriegelungssegment (328) aufweist, das so strukturiert ist, daß es sich durch die Öffnung (318) in der Schneidklinge (310) erstreckt.
16. Schneidklingenanordnung nach Anspruch 15, wobei das Verriegelungssegment (328) einen Flanschabschnitt (329) aufweist, der so strukturiert ist, daß er mit einer Kante der in der Schneidklinge (310) ausgebildeten Öffnung (318) in Eingriff treten kann.
17. Schneidklingenanordnung nach einem der Ansprüche 1 bis 16, wobei die scharfe, vordere Schneidkante (313) der Schneidklinge (310) so ausgebildet ist, daß sie einen Winkel von annähernd zwischen 5 bis 10 Grad von der horizontalen Achse der Schneidklinge (310) hat.
18. Schneidklingenanordnung nach einem der Ansprüche 1 bis 17, ferner mit einer Griffanordnung (360), die mit der Klingeneinheit (310, 320) lösbar verbunden und so strukturiert ist, daß sie die Einführung der Klingeneinheit in eine Zugriffsöffnung (156) einer Schneidkopfanordnung (50) erleichtert.
19. Schneidklingenanordnung nach Anspruch 18, wobei die Griffanordnung (360) so strukturiert ist, daß sie mit der Klingeneinheit (310, 320) wieder verbunden werden kann, um ein Entfernen der Klingeneinheit aus der Schneidkopfanordnung (50) zu erleichtern.
20. Schneidklingenanordnung nach Anspruch 18 oder 19, wobei die Griffanordnung (360) einen langgestreckten Schaft (362) aufweist, der so strukturiert ist, daß er mit dem Klingenhalter (320) entlang einer Seitenwand desselben verschraubt werden kann.
21. Schneidklingenanordnung nach Anspruch 18 oder 19, wobei die Griffanordnung (360) einen langgestreckten Schaft (362) aufweist, der mit dem Klingenhalter (320) einstückig ausgebildet und so strukturiert ist, daß er nach Einführung des Klingenhalters in die Schneidkopfanordnung (50) von diesem getrennt werden kann.
22. Medizinisches Gerät mit einer Schneidklingenanordnung nach einem der Ansprüche 1 bis 21 und einer chirurgischen Vorrichtung zum Schneiden im wesentlichen durch eine Hornhaut eines Auges eines Patienten, wobei die Vorrichtung aufweist:
- a) einen Positionierungsring (32) mit einer Einrichtung zum vorübergehenden Befestigen an einem Abschnitt des Auges, der die zu schneidende Hornhaut umgibt; wobei der Positionierungsring (32) eine Öffnung (33) bildet, die so bemessen ist, daß die zu schneidende Hornhaut aufgenommen und freigelegt wird;
 - b) wobei der Positionierungsring eine Führungseinrichtung (40) aufweist, die auf ihrer oberen Fläche auf einer im allgemeinen bogenförmigen Bahn ausgebildet ist;
 - c) eine Schneidkopfanordnung (50) mit der darin positionierten Schneidklingenanordnung (300) zum Schneiden der Hornhaut, wobei die Schneidkopfanordnung so strukturiert und angeordnet ist, daß sie über den Positionierungsring (32) hinweg entlang der im allgemeinen bo-

genförmigen Bahn bewegt werden kann, die durch die Führungseinrichtung (40) definiert ist;

d) eine Antriebseinrichtung (80), die mit der Schneidkopfanordnung (50) betriebsfähig gekoppelt ist und dazu dient, eine Bewegung der Schneidkopfanordnung über den Positionierungsring (32) und eine Hin- und Herbewegung der Schneidklingenanordnung (300) zu bewirken;

e) wobei die Schneidkopfanordnung (50) ferner aufweist: ein Hauptgehäuse (51) mit einer oberen Fläche (56') und einer unteren Fläche, einer vorderen Stirnfläche (52) und einer hinteren Stirnfläche (54), einer umgebenden Seitenwandstruktur (53) zwischen den Flächen und Stirnflächen, eine Innenkammer (88), die so strukturiert ist, daß sie die Schneidklingenanordnung (300) in einer Schneidposition aufnimmt und hält, und eine Schneidöffnung (56), die in der unteren Fläche ausgebildet ist, zum Freilegen einer Schneidfläche der Schneidklingenanordnung.

23. Medizinisches Gerät nach Anspruch 22, wobei die umgebende Seitenwandstruktur (53) eine darin ausgebildete Zugangsöffnung (156) aufweist und so angeordnet ist, daß sie im allgemeinen der Innenkammer (88) entspricht, so daß zumindest das Schneidelement auf einfache Weise eingefügt und aus dem Gehäuse (51) entfernt werden kann.

24. Medizinisches Gerät nach Anspruch 23, wobei die Zugangsöffnung (156) so strukturiert und angeordnet ist, daß sie sich von einer Seite zur anderen vollständig durch die umgebende Seitenwandstruktur (53) der Schneidkopfanordnung (50) erstreckt.

Revendications

1. Ensemble de lames d'incision (300) devant être utilisé avec un dispositif chirurgical qui incise au moins partiellement à travers la cornée de l'oeil d'un patient, le dispositif chirurgical comprenant l'ensemble de lames d'incision avec

a) une lame d'incision (310) présentant

i) une partie avant (312), ladite partie avant comprenant une arête tranchante avant affûtée (313) ;

ii) une partie arrière traînante (314) comprenant une arête arrière (315);

iii) une paire d'arêtes latérales (316, 317) interconnectant ladite partie avant et ladite

partie arrière traînante ; et

b) un porte-lame (320) étant relié pour coopérer à ladite lame d'incision (310) et structuré pour être entraîné, en utilisation par les moyens d'entraînement du dispositif chirurgical, caractérisé en ce que lesdites arêtes latérales (316, 317) de ladite lame d'incision (310) sont au moins partiellement en biais entre ladite partie avant (312) et la dite partie arrière traînante (314).

2. Ensemble de lames d'incision selon la revendication 1, dans lequel ladite paire d'arêtes latérales (316, 317) s'étendant entre ladite partie avant (312) et ladite partie arrière traînante (314) sont arrondies.

3. Ensemble de lames d'incision selon la revendication 1 ou 2, dans lequel ladite lame d'incision (310) est sensiblement plane.

4. Ensemble de lames d'incision selon l'une quelconque des revendications 1 à 3, dans lequel ledit porte-lame (320) est composé sensiblement d'un matériau plastique de manière à être jetable.

5. Ensemble de lames d'incision selon l'une quelconque des revendications 1 à 4, dans lequel ladite arête arrière (315) de ladite partie arrière (314) de ladite lame d'incision (310) est généralement parallèle à ladite arête tranchante avant (313) de ladite partie avant (312) de ladite lame d'incision (310).

6. Ensemble de lames d'incision selon l'une quelconque des revendications 1 à 5, dans lequel ladite partie avant (312) de ladite lame d'incision (310) est plus grande que ladite partie arrière traînante (314).

7. Ensemble de lames d'incision selon l'une quelconque des revendications 1, 3 à 6, dans lequel ladite partie avant (312) de ladite lame d'incision (310) présente une forme généralement rectangulaire et ladite partie arrière traînante (314) de ladite lame d'incision (310) présente une forme généralement trapézoïdale.

8. Ensemble de lames d'incision selon l'une quelconque des revendications 1 à 7, dans lequel ladite lame d'incision (310) comprend au moins une ouverture (318) formée en son intérieur.

9. Ensemble de lames d'incision selon la revendication 8, dans lequel ladite lame d'incision (310) est formée pour comprendre au moins une seconde ouverture (319) formée en son intérieur, lesdites ouvertures (318, 319) présentant une configuration généralement circulaire.

10. Ensemble de lames d'incision selon la revendication 8 ou 9, dans lequel ladite ouverture (318, 319) formée à l'intérieur de ladite lame d'incision (310) est disposée dans ladite partie arrière trainante (314) de ladite lame d'incision et présente une forme généralement circulaire. 5
11. Ensemble de lames d'incision selon l'une quelconque des revendications 8 à 10, dans lequel ladite partie arrière trainante (314) de ladite lame d'incision (310) comprend une paire desdites ouvertures (318, 319) formées en son intérieur et disposées en relation sensiblement alignée l'une par rapport à l'autre. 10
12. Ensemble de lames d'incision selon l'une quelconque des revendications 8 à 11, dans lequel ledit porte-lame (320) présente une face inférieure, ladite face inférieure dudit porte-lame étant fixée à ladite lame d'incision (310) au niveau de ladite au moins une ouverture formée dans ladite lame d'incision et une face supérieure (322) dudit porte-lame comprend des moyens destinés à être entraînés de manière utilisable par les moyens d'entraînement. 20
13. Ensemble de lames d'incision selon la revendication 12, dans lequel lesdits moyens sur ledit porte-lame (320) destinés à être entraînés de manière utilisable par les moyens d'entraînement comprennent une gorge (326) formée à l'intérieur dudit porte-lame. 25
14. Ensemble de lames d'incision selon la revendication 13, dans lequel ladite gorge (326) dans ledit porte-lame (320) est de forme généralement ovale. 30
15. Ensemble de lames d'incision selon l'une quelconque des revendications 8 à 14, dans lequel ledit porte-lame (320) comprend un segment de verrou (328) structuré pour s'étendre à travers ladite ouverture (318) dans ladite lame d'incision (310). 35
16. Ensemble de lames d'incision selon la revendication 15, dans lequel ledit segment de verrou (328) comprend une partie à bride (329) structurée pour mettre en prise une arête de ladite ouverture (318) formée dans ladite lame d'incision (310). 40
17. Ensemble de lames d'incision selon l'une quelconque des revendications 1 à 16, dans lequel ladite arête tranchante avant affûtée (313) de ladite lame d'incision (310) est formée pour présenter un angle d'approximativement entre cinq et dix degrés à partir d'un axe horizontal de ladite lame d'incision (310). 45
18. Ensemble de lames d'incision selon l'une quelconque des revendications 1 à 17, comprenant en outre un ensemble de poignées (360) relié de manière amovible à ladite unité de lames (310, 320) et structuré pour faciliter l'introduction de ladite unité de lames dans une ouverture d'accès (156) d'un ensemble de tête d'incision (50). 50
19. Ensemble de lames d'incision selon la revendication 18, dans lequel ledit ensemble de poignées (360) est structuré pour être de nouveau relié à ladite unité de lames (310, 320) de manière à faciliter le retrait de ladite unité de poignées dudit ensemble de tête d'incision (50). 55
20. Ensemble de lames d'incision selon la revendication 18 ou 19, dans lequel ledit ensemble de poignées (360) comprend une tige oblongue (362) structurée pour être couplée de manière filetée au dit porte-lame (320) le long d'une paroi latérale de celui-ci.
21. Ensemble de lames d'incision selon la revendication 18 ou 19, dans lequel ledit ensemble de poignées (360) comprend une tige oblongue (362) formée intégralement avec ledit porte-lame (320) et structurée pour être séparée de celui-ci à l'introduction dudit porte-lame dans l'ensemble de tête d'incision (50).
22. Appareil médical comprenant un ensemble de lames d'incision selon l'une quelconque des revendications 1 à 21 et un dispositif chirurgical destiné à inciser sensiblement à travers la cornée de l'oeil d'un patient, ledit dispositif chirurgical comprenant :
- a) un anneau de positionnement (32) présentant des moyens pour une fixation temporaire à une partie de l'oeil entourant la cornée devant être incisée ; ledit anneau de positionnement (32) définissant une ouverture (33) de taille à recevoir et exposer la cornée devant être incisée ;
 - b) ledit anneau de positionnement comprenant des moyens de guidage (40) formés sur une surface supérieure de celui-ci dans un chemin généralement courbe ;
 - c) un ensemble de tête d'incision (50) comprenant ledit ensemble de lames d'incision (300) positionné en son intérieur destiné à inciser la cornée, ledit ensemble de lames d'incision étant structuré et disposé pour être entraîné à travers ledit anneau de positionnement (32) le long dudit chemin généralement arqué défini par lesdits moyens de guidage (40) ;
 - d) des moyens d'entraînement (80) couplés de manière utilisable au dit ensemble de tête d'in-

cision (50) destinés à provoquer le mouvement dudit ensemble de tête d'incision à travers ledit anneau de positionnement (32) et destiné à provoquer un mouvement d'oscillation dudit ensemble de lames d'incision (300) ;

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e) ledit ensemble de tête d'incision (50) comprenant en outre un logement principal (51) comprenant une surface supérieure (56') et une surface inférieure, une face frontale (52) et une face arrière (54), une structure environnante de paroi latérale (53) entre lesdites surfaces et faces, une chambre intérieure (88) structurée pour recevoir et maintenir un ensemble de lames d'incision (300) dans une position d'incision et une ouverture d'incision (56) formée dans ladite surface inférieure destinée à exposer une surface d'incision dudit ensemble de lames d'incision.

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23. Appareil médical selon la revendication 22, dans lequel ladite structure environnante de paroi latérale (53) comprend une ouverture d'accès (156) formée en son intérieur et disposée pour correspondre généralement à ladite chambre intérieure (88) afin qu'au moins ledit élément d'incision puisse être facilement inséré et retiré dudit logement (51).

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24. Appareil médical selon la revendication 23, dans lequel ladite ouverture d'accès (156) est structurée et disposée pour s'étendre complètement à travers ladite structure de paroi latérale environnante (53) dudit ensemble de tête d'incision (50) d'un côté à l'autre.

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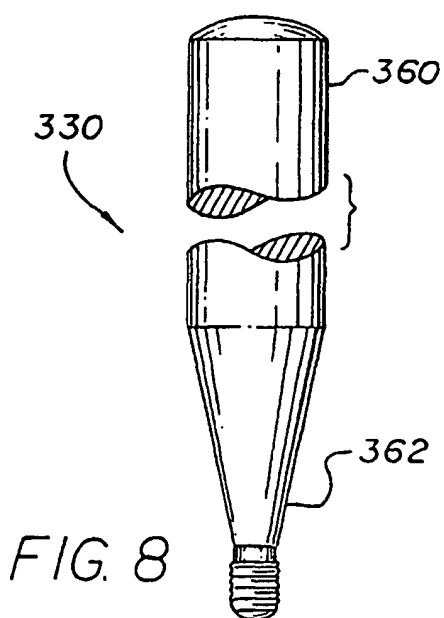
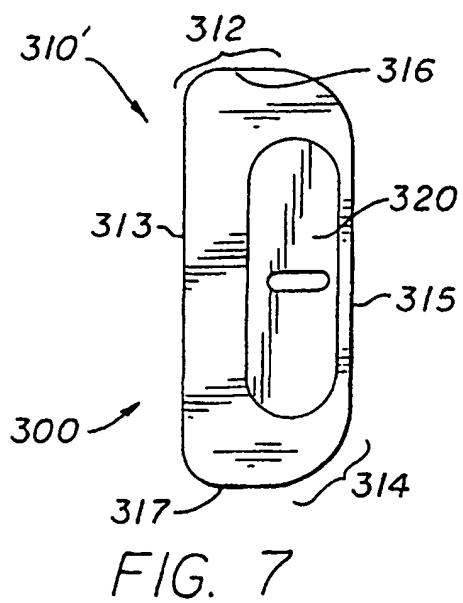
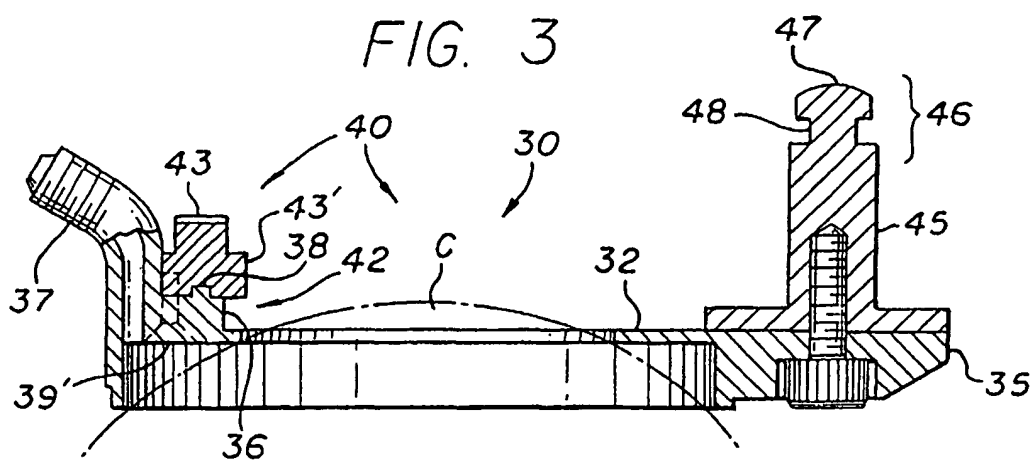
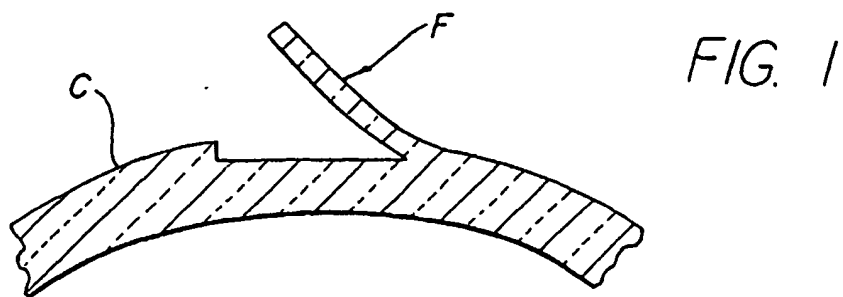


FIG. 2

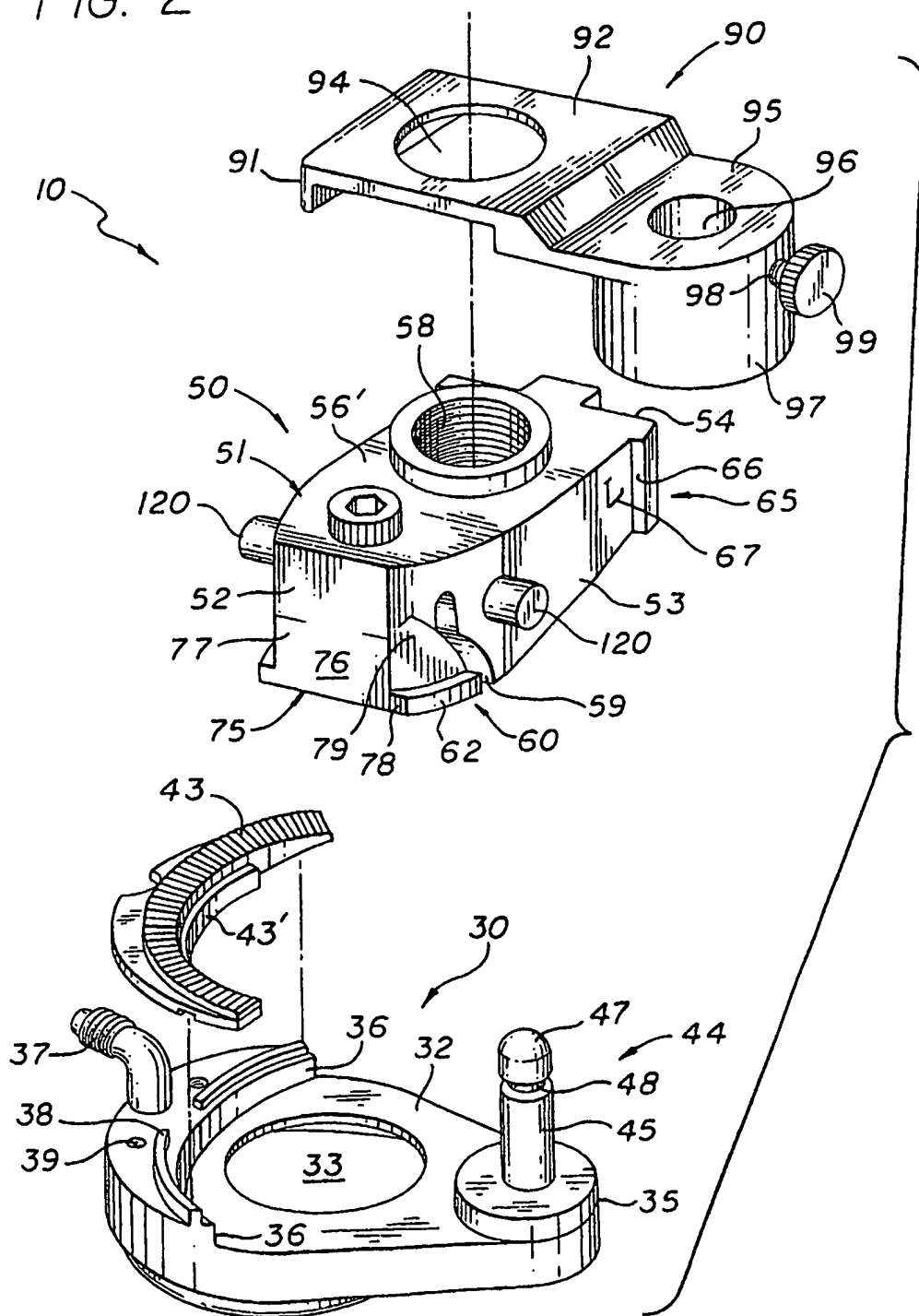


FIG. 4

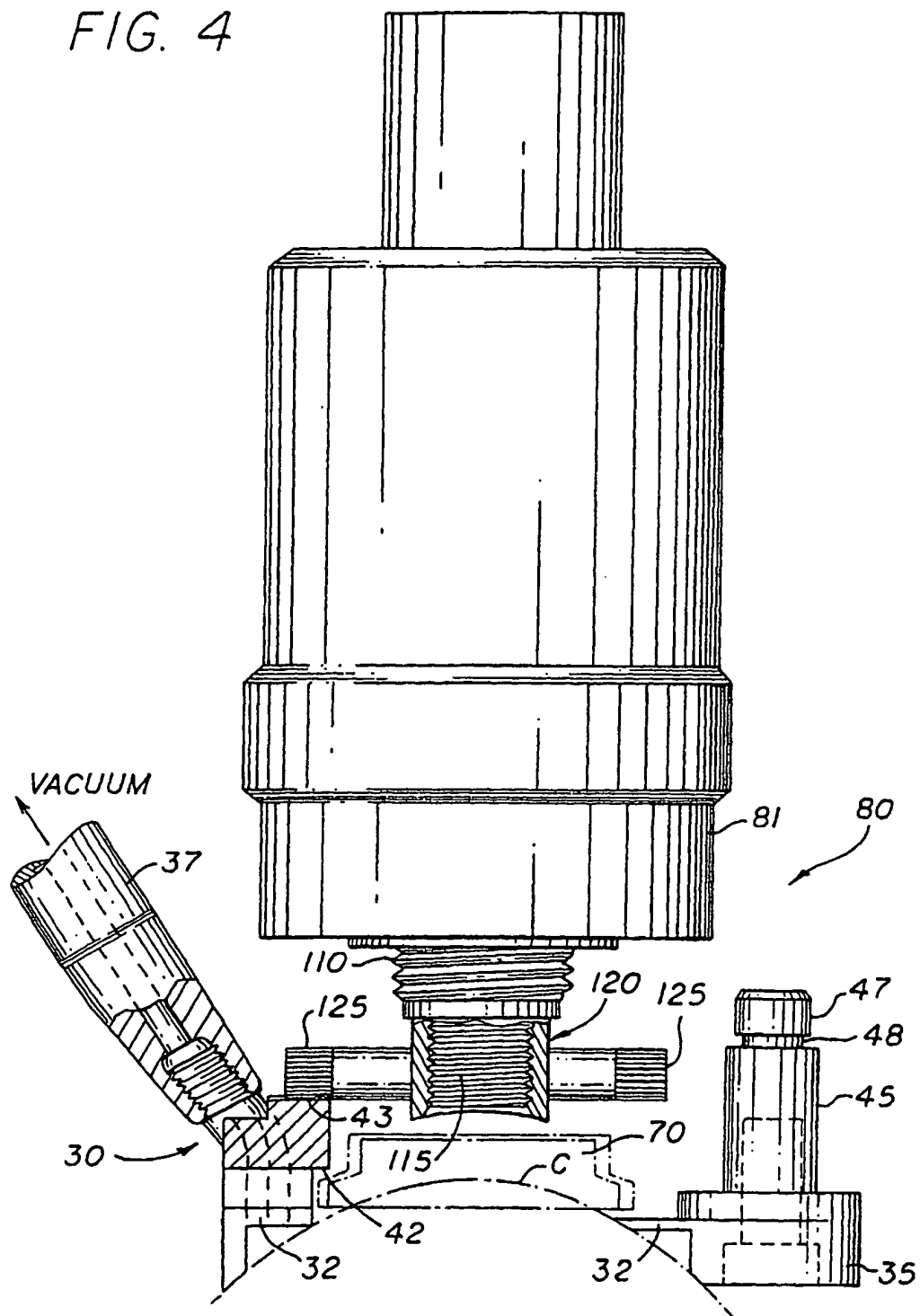


FIG. 5

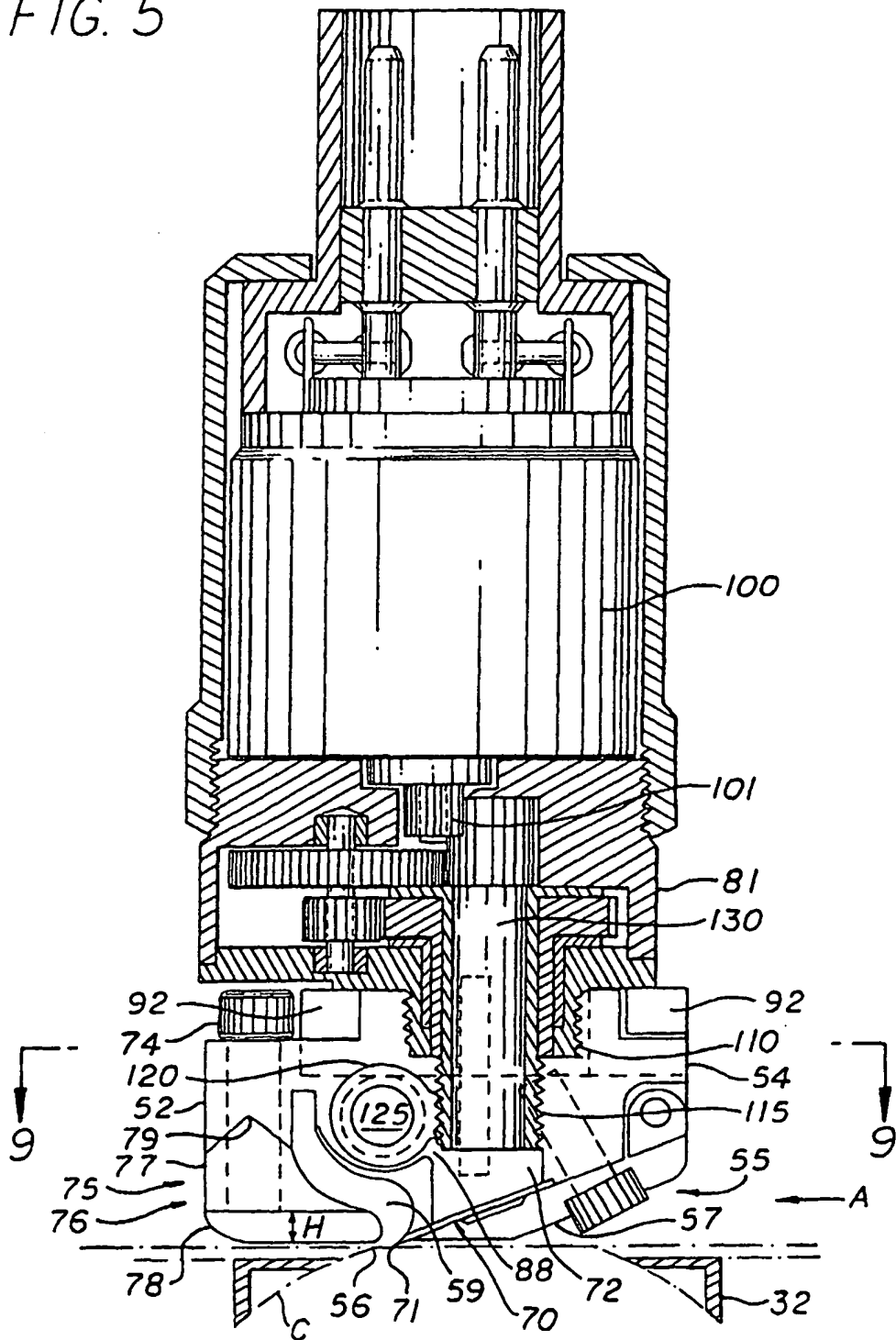


FIG. 5-A

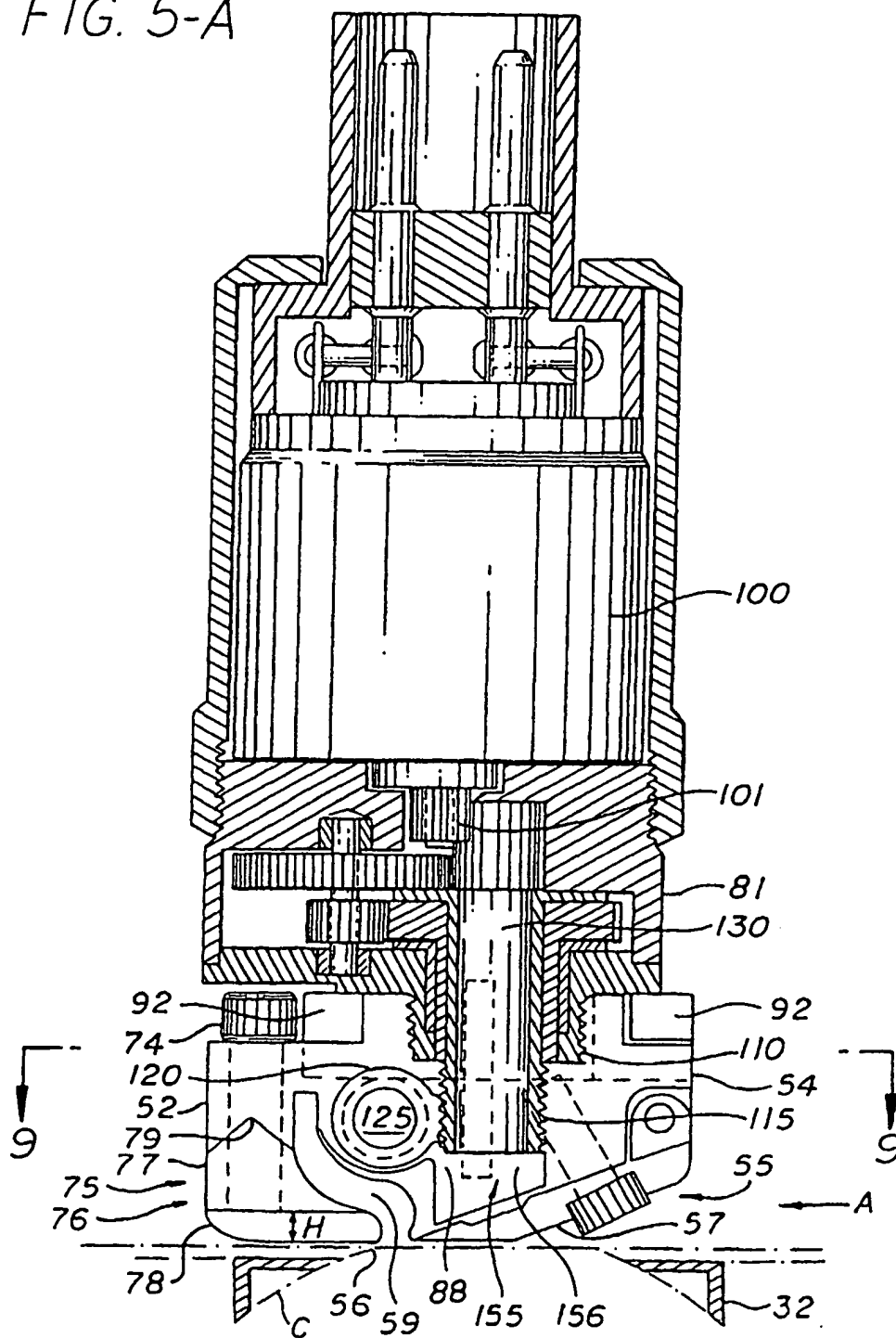


FIG. 6-A

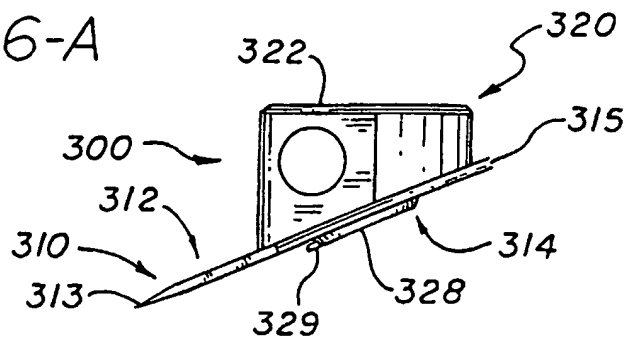


FIG. 6-B

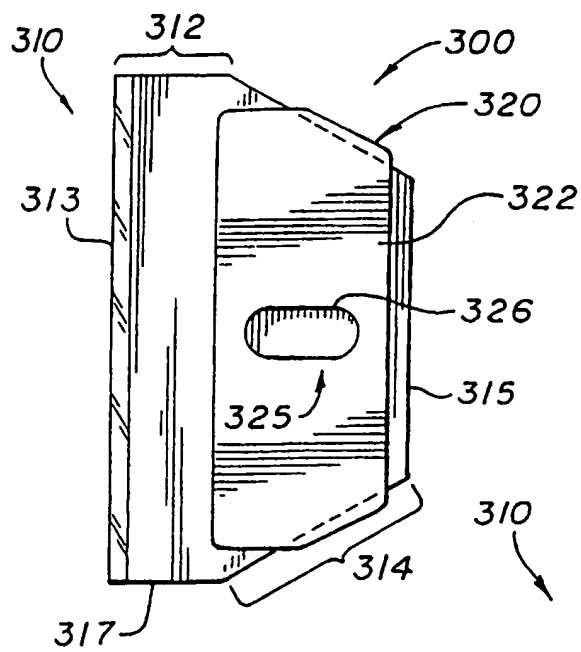


FIG. 6-C

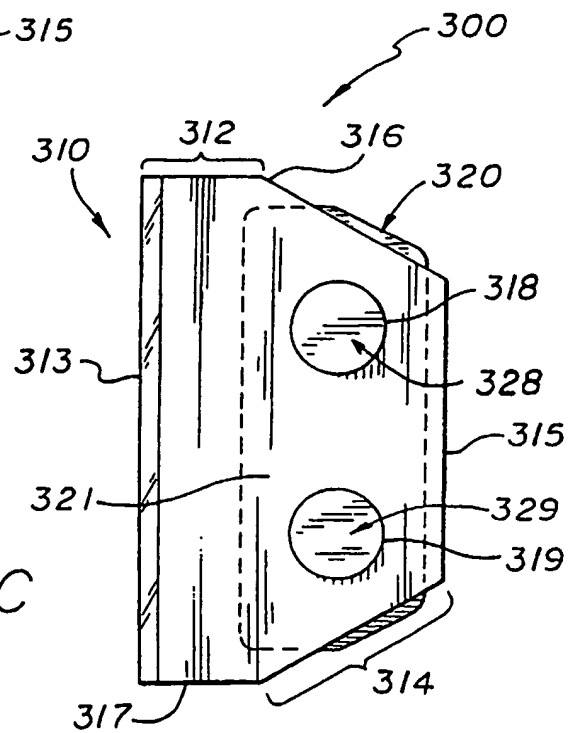
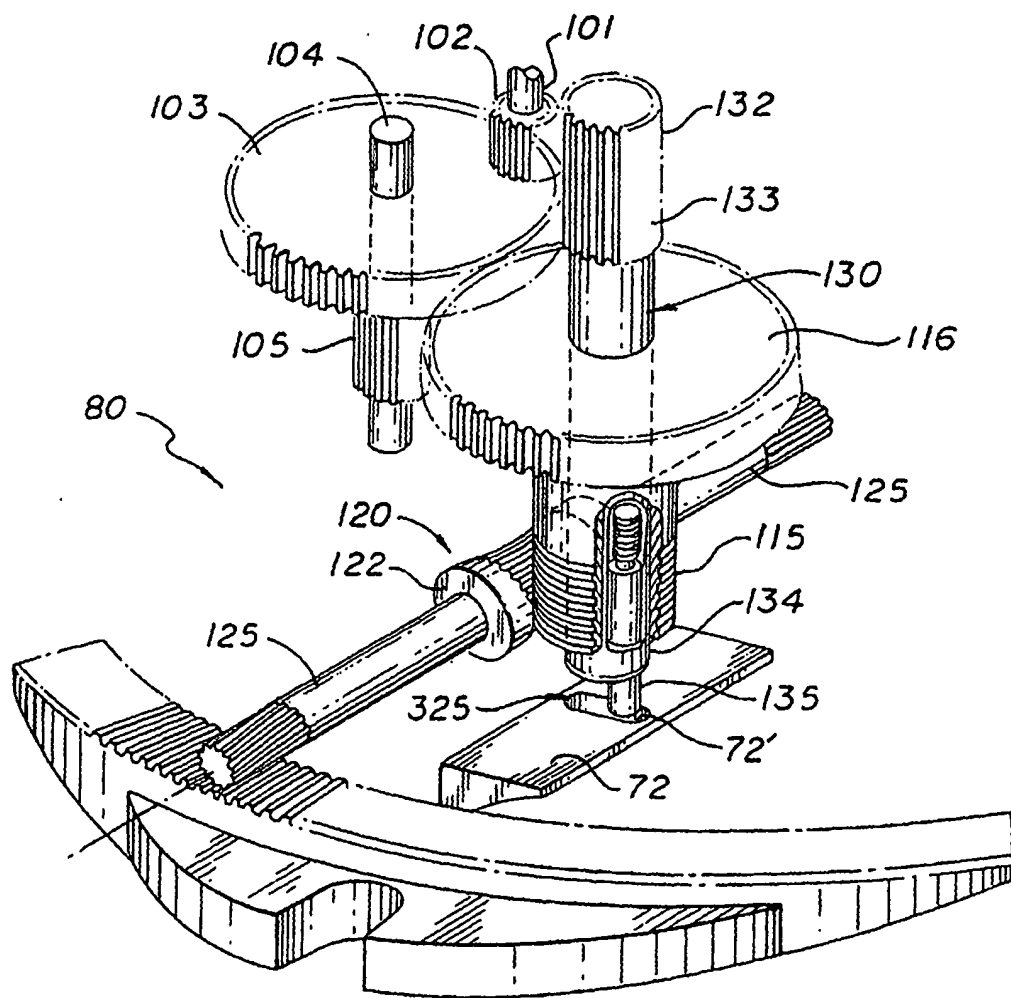


FIG. 9



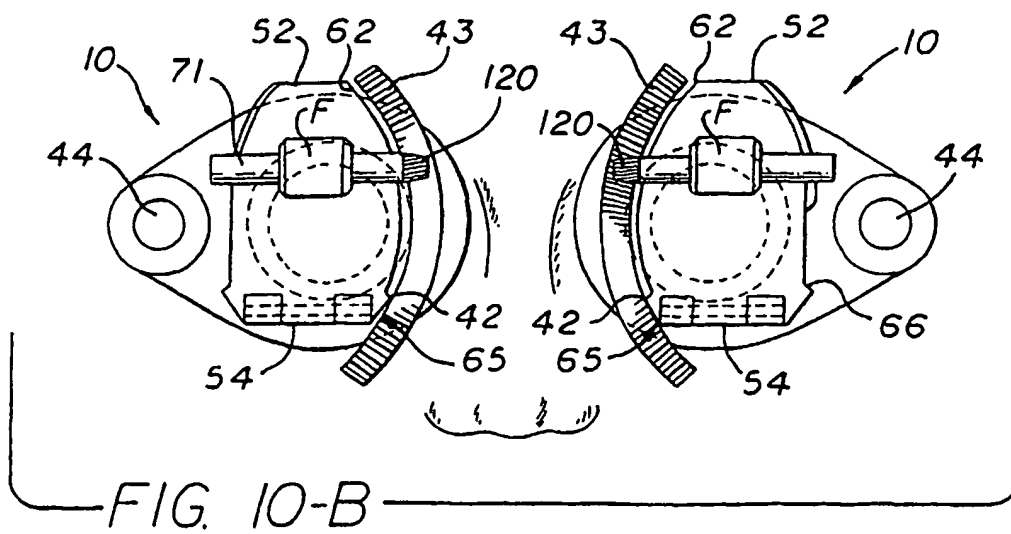
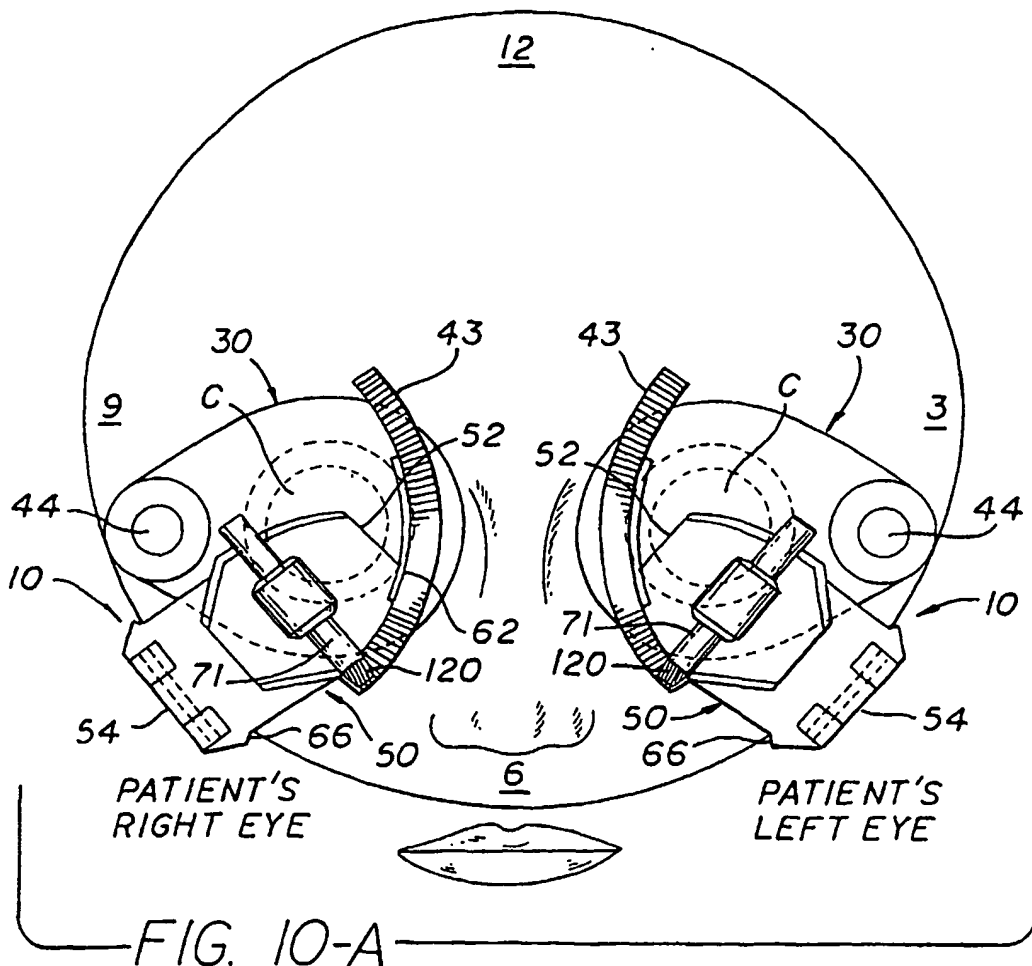


FIG. 11

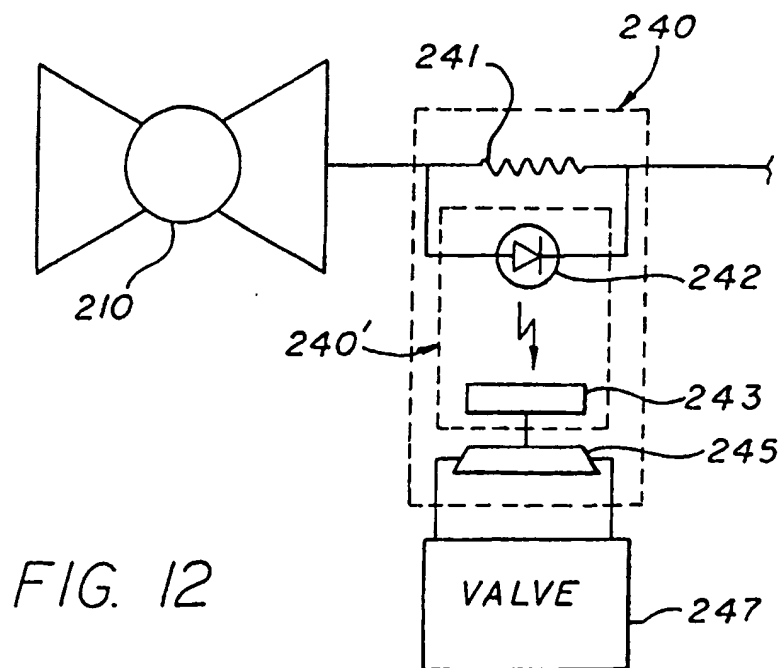
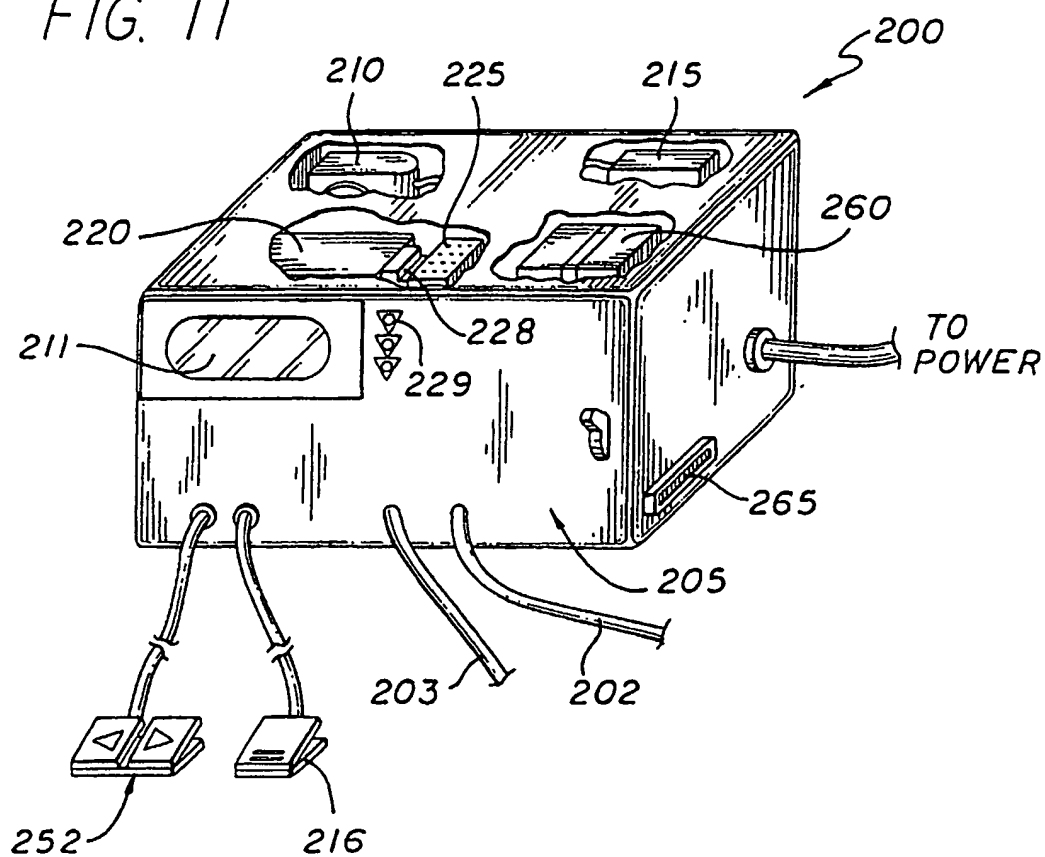


FIG. 12

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